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# Metamorphosis

image

BY JOE FORDHAM

Darren Aronofsky's films tend not to fit into easily classifiable paradigms. After his paranoid science fiction thriller *Pi*, the drug addiction parable *Requiem for a Dream*, the cosmic romance *The Fountain* and the brutal redemption drama *The Wrestler*, Aronofsky turned to a strange tale of obsession and fractured personality set in the rarefied world of the New York City Ballet.

Released by Fox Searchlight Pictures as *Black Swan*, the project began with Andrés Heinz's screenplay, *The Understudy*, about rival theatrical performers in an off-Broadway production. The screenplay evolved with Heinz, Mark Heyman and John McLaughlin, who developed the story into a psychological thriller about an ingénue prima ballerina, Nina Sayers (Natalie Portman), who struggles with her overbearing mother (Barbara Hershey), a manipulative director (Vincent Cassel), and a rival dancer, Lily (Mila Kunis), during a production of Tchaikovsky's *Swan Lake*. As Nina masters the ballet's lead role of a princess cursed by an evil sorcerer to take the form of a swan, she slowly loses her grip on reality and experiences a series of hallucinations that make her believe she is physically transforming into a half-swan, half-human creature.

Aronofsky and his longtime director of photography, Matthew Libatique, brought the bizarre scenario to life on a rapid production schedule, shooting the movie on Super 16mm film and making extensive use of New York City locations, including exteriors of Lincoln Center for the Performing Arts, the real-life home of the New York City Ballet. For theater interiors, production designer Thérèse DePrez repurposed backstage environments and the auditorium at the State University of New York Purchase College Performing Arts Center, located in upstate New York.

The climax of the film occurs during the final act of *Swan Lake*, when Nina achieves the realization of her dream and physically transforms on stage before an opening night crowd. The methods for achieving Nina's transformation became an early focus for the production. "Darren always has romantic visions of doing everything practically," observed visual effects supervisor Dan Schrecker, a key contributor to all of Aronofsky's films since their student days at Harvard University. "Darren enlisted Mike Marino as prosthetic effects designer, and they produced conceptual art and talked about different ways of building the effects. But it became apparent early on that this couldn't be done entirely practically."

Marino, who had first worked with Aronofsky on the prosthetic crew for *Requiem for a Dream* and had more recently supervised prosthetic effects for *The Wrestler* from his Prosthetic Renaissance studio in Brooklyn, explored ideas for a hybrid approach of practical and digital effects. "The transformation was a psychological thing," stated Marino. "Nina is the only one who sees it, and the audience is never sure if it's really happening, or if it's in her head. We were riding a fine line of how far we could push the fantasy. I suggested to Darren that we create multiple mid-transformation pieces that he could shoot and Dan could track to Natalie as she was dancing."

Due to the complexity of tracking multiple animatronic transformation pieces to a highly mobile dancer, that solution was deemed impractical and led the filmmakers to focus on an all-digital

approach for Nina's final transformation, while still using prosthetics to establish earlier manifestations of her psychosis.

For the digital transformation, Aronofsky encouraged Schrecker and his team at LOOK Effects to explore nature reference that would help to define the fusion of human and swan anatomy. "Darren bought a swan skeleton," said Schrecker. "He had the idea that we could build a CG swan skeleton from that, do some motion capture of a dancer, and map scans of swan anatomy onto the human dancer. We went back and forth as to how that would work, and we decided that we didn't need to lidar scan the swan skeleton to map it onto a dancer; but Darren's point was well taken. He wanted to start with something realistic and figure out how a swan moved, how a swan's wings are built and how that anatomy might translate to the human form."

To lay groundwork for the transformation, Schrecker conducted a motion capture test with Curious Pictures, using a dance double to enact *Swan Lake* choreography, which LOOK Effects used to create early digital tests. "We knew we had to keep Nina's legs human as she transformed," Schrecker explained. "There was no way that we could have her turn into a complete swan, or she would not have been able to dance. So we concentrated on her arms, turning them into wings, which we knew had to be central to the transformation. We then played around with permutations of her head and her face—making Natalie more bird-like, elongating her face into a bill, adding a long swan neck, and making feathers spread up over the top of her head like a cowl. It was important for the transformation to be beautiful because, in Nina's mind, this was her crowning achievement; and so, anytime the transformation started to look too weird or not pretty any more, we backed away."

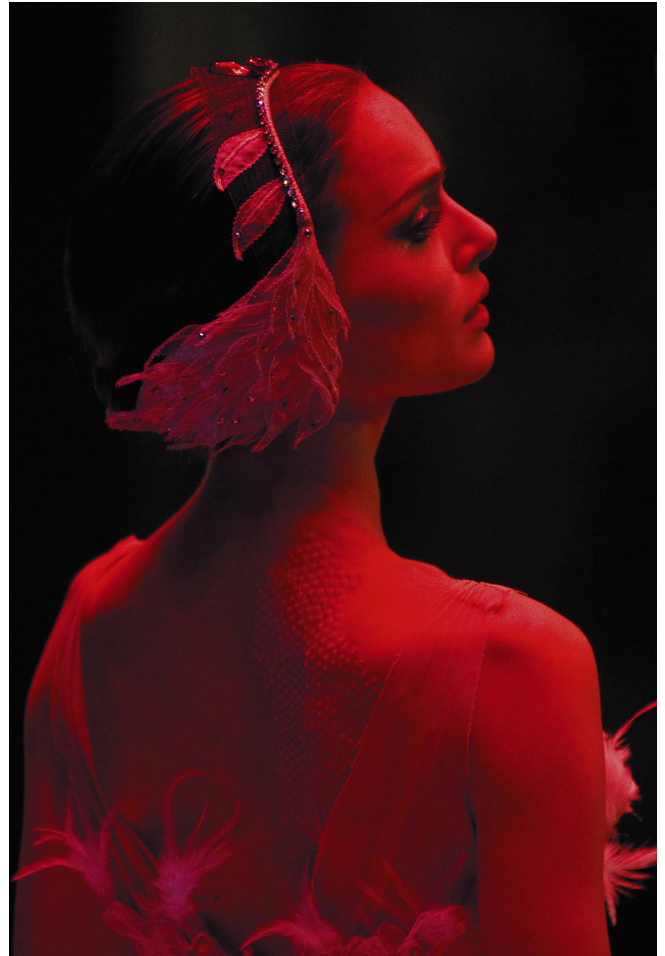
The 3D tests incorporated conceptual work developed simultaneously at Prosthetic Renaissance where a team of 2D artists—Marino, Aaron Sims, Paul Komoda and Daphne Yap—experimented with transformation looks. Meanwhile, Marino and his lab supervisor, Chris Kelly, conducted extensive lifecasting of Natalie Portman for use in building early-stage prosthetics and animatronic pieces, while Dan Schrecker's team photographed and scanned Portman and Kunis to capture textures and geometry of the performers. The 3D data fed into construction of a digital swan transformation rig that LOOK Effects digital artist Shawn Lipowski developed. Schrecker and visual effects producer Colleen Bachman then worked with visual effects supervisor Henrik Fett and visual effects producer Melinka Thompson-Godoy to complete the 210 visual effects shots needed for the film.



Aronofsky opens the film with a surreal dream sequence in which Nina envisions herself dancing *Swan Lake*, spot-lit in an impressionistic monochromatic stage setting, filmed at SUNY Purchase. To transform the stage floor into a pristine surface, LOOK Effects 2D supervisor Michael Collins integrated a digital surface beneath the dancers' feet, including a caustics pass that created a subtle underwater effect. The dream climaxes with Nina's dancing partner transforming into Rothbart (Sergio Torrado), the demonic sorcerer from *Swan Lake*. As Rothbart spins, Collins produced a 2D animation that transformed Torrado in a 'demon morph,' animating Rothbart's horns to grow. This transitioned into Torrado wearing a prosthetic makeup of a menacing bird-like creature that Mike Marino's crew generated—using silicone appliances for forehead, nose, upper lip, chin, lower lip, cheeks, ears and finger tips—which the wardrobe department combined with a feathered costume.

After waking in her mother's New York City apartment, Nina notices a patch of inflamed skin on her right shoulder. Prosthetic Renaissance generated Nina's rash, signifying the onset of her transformation, as a series of makeup appliances. "We made eight stages of Nina's rash," related Mike Marino. "It started with very tiny scratches, then progressed to little bumps here and there, to almost covering her whole back. Darren wanted the textures to be symmetrical patterns, a little like chicken skin. We tried many different ways of creating that, including punching sheet metal, but wound up molding tiny BB bullets and making appliances out of that."

Rash applications for Nina's physically grueling dance maneuvers put special demands on prosthetic adhesive properties. "We first tried making appliances in silicone, which I thought would be more durable," said Marino, "but we found that with Natalie's dancing, the pieces were compromised and the paint was coming off. We then tried using Pros-Aide transfers—casting Pros-Aide adhesive into a flat silicone mold, transferring appliances onto paper, wetting the paper and transferring those onto the skin—but we found that smashed the textures. We ended up spraying vinyl into the mold as a release agent. We cast tinted Pros-Aide into that, applied glue where we wanted the rash to be, and then pressed the mold directly onto Natalie's skin. When we peeled off



*Backstage pressures and rivalries during a New York City Ballet production of Swan Lake cause prima ballerina Nina Sayers (Natalie Portman) to suffer a series of disturbing hallucinations in Black Swan. The art house hit, filmed on a modest budget on locations in New York, was a surreal and uncompromising passion project from director Darren Aronofsky that depicted the central character's physical transformation into a swan-human hybrid. To create the manifestations of Nina's visions, Aronofsky's regular collaborator, visual effects supervisor Dan Schrecker, teamed with LOOK Effects and makeup effects supervisor Mike Marino at Prosthetic Renaissance.*

the mold, the appliances came out clean and then we tweaked and painted the makeup. That gave us all the texture detail and enabled us to do applications very rapidly, in five to ten minutes.”

As pressures mount during dance rehearsals, Nina is plagued by injuries, real and imagined. During a home rehearsal, Nina painfully stubs her toe and shatters a toenail. Mike Marino’s team created the toenail injury as a sculpted silicone appliance that slipped over Portman’s big toe, onto which they then applied a urethane copy of her toenail, dressed with blood.

Nina later experiences an imagined injury at a backstage bathroom sink, picking at her skin in an obsessive-compulsive moment of self-mutilation. Prosthetic Renaissance developed a makeup application on Portman’s cheek that the actress could peel away in layers, until she washed the wound away. A last-minute change called for an even more excruciating vision. “Darren called me late at night and said, ‘Hey man, I’ve got a better idea,’” recalled Mike Marino. “He wanted Nina to peel back a cuticle on her finger, ripping the skin down to her knuckle. It was a challenge to do that without much prep, but we made an appliance for Natalie’s finger that had a section already pre-ripped. We molded that and sculpted a piece to fill that torn area. We glued the first piece onto Natalie’s finger, which had an insert piece made out of a softer silicone, so she could grab it and rip it off.” LOOK Effects then warped the prosthetic digitally to bring it closer to Portman’s true finger girth.

Another injury occurs when Nina clips her fingernails at her bathroom mirror and accidentally snips a fingertip, which profusely bleeds. The prosthetic team supplied a mechanical hand for the scene. “We made a copy of Natalie’s hand rigged with blood tubing,” said Marino. “Our mechanical designer, Jerry Constantine, built a cable-controlled mechanism into the fingertips and we covered that with a silicone skin. We put a handle on the arm so Natalie could hold the hand in place, and then we had three puppeteers manipulating it off-camera. I pumped the blood.” LOOK Effects then digitally



*Nina’s psychological breakdown begins small-scale as she experiences a series of injuries, real and imagined. In a backstage bathroom, she picks at the skin of a hangnail, tearing her cuticle to the knuckle. Mike Marino’s team used a lifecast of Natalie Portman’s hand to generate a silicone finger appliance that Portman wore on set. LOOK Effects then digitally slimmed the prosthetic’s girth.*



reshaped the prosthetic to enhance the blend to Portman's body as the hand bled into the sink.

Hallucinations become more surreal when Lily coaxes Nina to take drugs in a nightclub, causing Nina to see bird-like skin textures flushing across her hand. LOOK Effects generated the skin-rippling effect using photographic reference of an earlier makeup application. "When Nina first starts to feel the drug," related Dan Schrecker, "we elongated her hands and made bumps appear on her hand, like chicken skin. We generated those textures in CG, and then animated them to pulsate and move."

*At home, Nina clips a fingernail too close, causing massive bleeding. Aronofsky filmed the scene with Portman articulating an animatronic hand that Marino's team puppeteered and rigged to spew blood.*



Music and flashing lights intensify Nina's hallucinations when Lily lures her onto the dance floor. The production staged the sequence in a New York nightclub dressed with mylar wall coverings, which reflected red and green strobe lighting. Visual effects artist Ray Lewis then collaborated with film editor Andrew Weisblum to create an impressionistic hallucinatory montage. "Darren shot about 30 minutes of footage for that two-minute sequence," observed Lewis. "The red and green strobes were pulsing off-rhythm with each other, so the challenge was to find images of Natalie and Mila that happened to be the same color. I then extracted the characters and manipulated them with other imagery, incorporating elements into the background. I used images of the cheesy pink butterfly wallpaper from Nina's bedroom, which I had photographed on set, and worked those into the background. I added images of the sorcerer demon from Nina's ballet, and blurred out other characters' faces in the frame. I did animated moves or morphs over three or four frames in Nuke, though most of it was Photoshop. It was a ton of work, at least 1,000 frames."

After the nightclub, Nina returns home, still feeling the effects of alcohol and drugs, and makes love with Lily. During the scene, Nina's skin ripples with rash textures, and a tattoo on Lily's back transforms from a floral motif into a bird wing design. For an insert shot of Nina's back undulating with cartilage pushing out of the skin, Mike Marino's team built a silicone mechanical prosthetic back, but the shooting schedule did not allow time to film the effect. "Because of the sensitive nature of shooting," explained Dan Schrecker, "there wasn't time to do prosthetic work. We added some simple tracking markers on Natalie's body and Mila's back. That gave us something to track, and then we animated the skin rash and Lily's tattoo."

Makeup designer Judy Chin and makeup department head Margie Durand created a tattoo transfer for Mila Kunis in the beginning of the scene, and then LOOK Effects created skin transformations as digital effects. The flexing surfaces of the contorting bodies required a month and half of manual labor to track. "It was matchmoving at the highest level," commented Henrik Fett. "The tracking



*Nina seeks out her predecessor, former prima ballerina Beth Macintyre (Winona Ryder), and finds the woman hospitalized with gruesome injuries to her legs after a traumatic accident. Mike Marino's team created prosthetics for the scene, applying silicone appliances to Ryder's face and affixing dummy legs. Makeup designer Judy Chin tends to Ryder on the hospital set.*



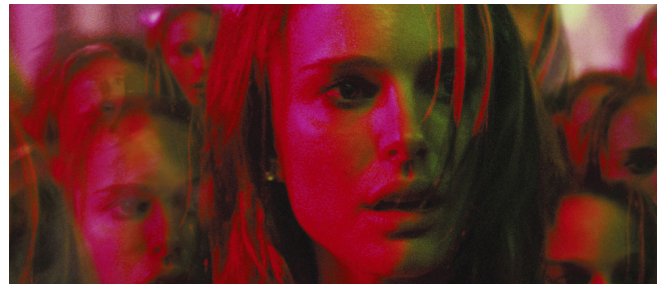
*Mike Marino adds airbrush coloration to a prosthetic makeup for Rothbart (Sergio Torrado), the demonic sorcerer from Swan Lake, who appears on stage as a dancer in the ballet and haunts Nina as a lurking hallucinatory presence.*

marks gave us a starting point, but because the actresses' bodies were stretching and bending in some very unexpected ways, a lot of it fell to the artists' interpretation."

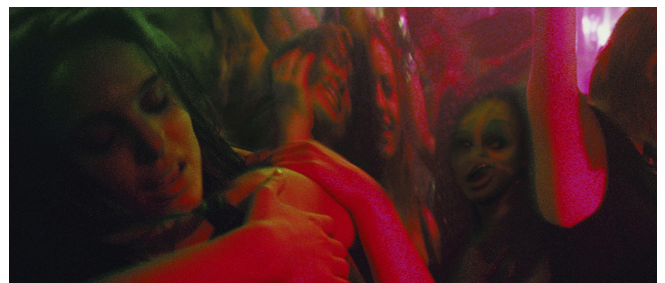
LOOK Effects 2D supervisors Brad Kalinoski and Michael Collins used The Pixel Farm's PFTrack to track production plates. A scan of Portman's body served as the basis for creating a 3D animation rig of body parts, which artists matchmoved to the performer. For Lily's tattoo, Dan Schrecker animated 2D art to transform from flowers to wings, which LOOK Effects then projected onto Kunis' skin. "We used Mila's natural skin texture and the lighting on her skin to integrate the animation to the geometry of her back," said 3D supervisor Michael Capton. "We had a variety of ways of doing Nina's digital chicken skin effects. In some closeups, we tracked the textures in 3D and then LOOK Effects' compositor blended the bumps to the skin surfaces, using elements that our 3D department supplied, and incorporated those onto sculpted body pieces that were tracked to Natalie's movement. In other shots, LOOK Effects compositor Buddy Gheen matchmoved textures onto Nina's skin and then used mattes to reveal those textures traveling up and down Nina's body."

After making love, Nina loses consciousness and later becomes increasingly confused and frightened by glimpses of a doppelgänger—her insolent double, who haunts her first in a New York subway underpass, and then backstage at the theater. Matthew Libatique shot subway scenes on location, guerrilla style, with a handheld Canon Mark IV digital SLR camera. A body double portrayed wide shots of the doppelgänger appearing from the gloom, and then LOOK Effects digitally tracked Portman's face onto the double. For a medium closeup of the doppelgänger walking close by Nina, Aronofsky shot repeat takes of Portman playing both roles. LOOK Effects tracked those elements and combined them in a digital composite.

The doppelgänger later manifests in a theater fitting room where Nina stands between two mirrors, reflected like a hall of mirrors, and one of her reflections reaches up to scratch the shoulder rash, out of sync with its neighbors. LOOK Effects previsualized the scene in Maya to work out the timing and placement of elements. Aronofsky then shot the scene with Portman standing between a pair of two-way mirrors, the camera positioned behind one mirror looking past at Portman's back. Portman performed the scene, stretching and swaying from side to side and reacting to her hallucination. The production then inserted a portable greenscreen and Aronofsky shot Portman as



Lily (Mina Kunis), a free-spirited young dancer from the ballet company, encourages Nina to take a break from her backstage pressures with an excursion to a New York City nightclub, where they indulge in alcohol and drugs, and Nina experiences hallucinations on the dance floor. Aronofsky filmed the sequence on location in a New York club dressed with mylar wall coverings that reflected pulsating red and green strobe lights. Film editor Andrew Weisblum assembled the sequence with visual effects artist Ray Lewis, crafting a montage of impressionistic images that depicted Nina's intoxication by rotoscoping Lily and Nina, isolating them from the other dancers, and then recombining shots with image treatments and distorted backgrounds. Subliminal details layered into the scene included fleeting glimpses of the demon Rothbart and apocalyptic imagery drawn from classical art.



Lily (Mina Kunis), a free-spirited young dancer from the ballet company, encourages Nina to take a break from her backstage pressures with an excursion to a New York City

the double, scratching her shoulder and turning to look behind her. LOOK Effects compositor Greg Silverman digitally painted out Portman's third reflection and composited the doppelgänger element in its place, so the rogue reflection appeared to stare back at Nina while others moved back and forth.

Later, as Nina is practicing alone in the theater rehearsal room surrounded by wall-mounted mirrors, she notices her reflection lagging behind her in a spin. Nina then backs into a mirror on the

facing wall where another of her reflections gives her a dirty look. Aronofsky shot multiple takes of Portman performing Nina's moves and repeat takes for rogue reflection passes. LOOK Effects rotoscoped elements, combined alternate Nina elements, and digitally painted out reflections of the camera crew.

Disturbed by the visions, Nina flees the theater to visit her predecessor, former prima ballerina Beth Macintyre (Winona Ryder), who has been hospitalized after a traumatic accident. Mike Marino's crew simulated Beth's injuries using silicone appliances of a swollen nose, swollen eye, extensive bruising and contusions. Ryder performed the scene on a cutaway mattress, with her body blended into dummy legs scarred with grisly wounds. To add to the horrific effect, property master Daniel Fisher dressed the faux wounds with live maggots. In postproduction, when Aronofsky called for an editorial change, LOOK Effects removed the maggots and mapped in photographic textures of the prosthetic with additional deep scars.

Nina recoils from Beth, who lashes out at her and, in a fit of madness, grabs a nail file to stab her own face. Dan Fisher's team provided a dummy nail file with a collapsing blade for Ryder to wield, and fitted the prop with a tiny sponge dipped in red liquid, enabling Ryder to mark her own face during her performance. LOOK Effects used the sponge marks to track in elements of a CG nail file blade puncturing Ryder's face, and added elements of squirting blood.

Nina flees the hospital and returns home, where she sees a room full of her mother's artwork come to life as a gallery of screaming and contorting faces. The art department supplied the art set dressing to LOOK Effects, which animated the images. "They gave us approximately 30 paintings and five photographs," recalled digital compositor Ulysses Argetta. "Darren wanted the photographs to melt, and all the pictures had to be talking and animating—eyes moving, faces emoting and mouthing specific lines of dialogue. I took pictures of myself to study mouth positions—I have a background in animation, so that experience lent itself quite well to those shots. I keyframe-animated all the images, and then we tracked them into the scene."

In her bedroom, Nina experiences muscle spasms as her shoulder blade cracks and juts alarmingly out of joint. Aronofsky filmed Portman enacting the back spasm without any prosthetic effects. LOOK Effects Flame artist Gabriel Sanchez then generated warping effects. "Darren wanted Nina's shoulder blade to jut out quickly and violently," explained Dan Schrecker. "It helped that Natalie

*nightclub, where they indulge in alcohol and drugs, and Nina experiences hallucinations on the dance floor. Aronofsky filmed the sequence on location in a New York club dressed with mylar wall coverings that reflected pulsating red and green strobe lights. Film editor Andrew Weisblum assembled the sequence with visual effects artist Ray Lewis, crafting a montage of impressionistic images that depicted Nina's intoxication by rotoscoping Lily and Nina, isolating them from the other dancers, and then recombining shots with image treatments and distorted backgrounds. Subliminal details layered into the scene included fleeting glimpses of the demon Rothbart and apocalyptic imagery drawn from classical art.*



was wearing a sweatshirt; we were able to come up with 2D solutions to make her shoulder move by mesh-warping the image with a little bit of digital paint work.”

Nina removes her sweatshirt to see her shoulder rash inflamed and small black spines protruding, one of which she plucks out to reveal a tiny vestigial feather. Aronofsky initiated the effect with Portman pulling a practical feather from a prosthetic on her shoulder. “We made a copy of the rash as a thicker appliance with the feather spine inside,” explained Mike Marino. “We experimented with many different techniques to create the feathers, and ended up using real feather spines that we shredded and broke up like little bones. We fitted them underneath the appliance by cutting out a little space and stretching it open, and then glued in the little spines that Natalie could pull out.”

LOOK Effects enhanced the prosthetic using the geometric arrangement of the makeup texture to track the rash on Portman’s shoulder, and added protrusions that subtly breathe and flush with color. They then tracked the tiny feather in Portman’s fingertips and added a subtly animated 3D version. “Darren wanted to see the feather unfurl,” said Henrik Fett. “He wanted it to feel quite soft as she pulled it out; and then, as she held it up in front of her face, it blossomed like a flower.”

Nina’s eyes redden through the sequence, becoming bloodshot and darkening to resemble black swan eyes. Mike Marino designed a series of six custom contact lenses, which Portman wore on set. LOOK Effects then generated digital transitions. “Nina’s eye transitions were pretty quick,” remarked Dan Schrecker. “In the scene where she pulls the feather out of her shoulder, we shot Natalie looking in the mirror wearing the red lenses. We painted them out, added her normal eyes, and revealed her bloodshot eyes with an animated matte so they appeared to turn red over a second. We had other shots where Natalie wore the lenses, and then we digitally made the pupil dilate and turn black.”

Nina steps away from her mirror as her legs snap backwards to resemble a bird’s legs. For a wide shot of Nina standing in the middle of her bedroom, visual effects inserted a portable greenscreen behind Portman in the set. Aronofsky directed Portman to enact the contortions, violently sagging down first on one leg, then the next as if experiencing her legs folding painfully beneath her. Portman then stepped out of frame and Mike Marino installed a pair of puppet legs that were mechanized to snap. “We made a fiberglass and foam-filled version of Natalie’s legs up to the pelvis,” said Mike Marino. “We built lightweight armatures to go inside, which we rigged to hyper-extend as each leg cracked backward. We dressed the prop, fitted it with shoes, and fixed the feet to the floor with double-stick tape. I then puppeteered each leg from above, so one snapped back and then the other. Darren filmed that a bunch of times.”



*Following her debauched nightclub outing, Nina brings Lily home and has sex with her. During the act, she hallucinates a tattoo shifting fluidly across Lily’s back. Judy Chin and makeup department head Margie Durand created a tattoo transfer, in a floral leaf design, that Mila Kunis wore throughout the film. For the tattoo transformation, the actress wore tracking marker dots, which LOOK Effects then tracked to re-create – on 3D geometry – the complex motion of Kunis’ back and shoulder muscles.*

LOOK Effects compositor Joseph Oberle extracted Portman's upper body from the greenscreen plate and tracked the element to the puppet legs with a join at the actress' waistline. Compositors then applied 2D digital warps to enhance the legs' avian appearance. In a closeup of the legs, LOOK Effects applied further warping to make the limbs appear thinner and more angular, and splayed the toes to form bird-like tripod feet.

By opening night, Nina has recovered from her contortions; but as she prepares to strap on her ballet shoes, she discovers that her toes have fused together. Mike Marino applied spirit gum between the toes of Portman's right foot, creating adhesion that Portman could peel apart, and applied prosthetics to her left foot. "We sculpted an appliance to fuse her pinkie toe to the one beside it," related Marino. "The middle toe was independent, then we had a second appliance over her other toes. We generated that as a silicone gel-filled appliance that we slipped over her real toes, and blended that to match her skin tone, which made it look like a three-toed bird foot."

Nina performs the first act of the ballet wearing theatrical makeup, designed by Judy Chin, and prosthetic rash appliances that Mike Marino applied to Portman's shoulders. During her performance, Nina stumbles on-stage, and then storms back to her dressing room, where she is enraged to find Lily preparing to take over her role as the *Black Swan* for the ballet's finale.

The reveal of Lily seated at Nina's makeup mirror featured the film's only use of motion control, in a disorienting bait-and-switch between Mila Kunis and a repeat take of Natalie Portman, dressed identically as Nina's *Black Swan* doppelgänger. "We started on a closeup of Lily," explained Dan Schrecker. "The camera then panned to her reflection, which was Natalie as Nina. We then panned back and revealed Nina sitting in front of the mirror." Schrecker made use of a Mo-Sys Lambda digital remote head—a compact motion encoder system operated by Guillaume Renberg of Monster Remotes—that recorded and played back the move with minimal technical setup. "It was one of our cleanest visual effects shots in the film. We wanted to keep it that way because we knew how Darren had struggled to get this movie made, and we didn't want to impose a lot of complicated technical restrictions on set. It was a very small set, with a lot of mirrors, and we hid the camera in the corner. The operator operated the repeat head remotely in another room with Darren, and we got it the first time."

Nina attacks her doppelgänger, smashing her into a full-length mirror and then throttling her. Aronofsky staged the mirror crash with Portman propelling a stunt double into breakaway glass,



*To generate the transforming tattoo, Dan Schrecker created 2D animation of the tattoo design flowering sinuously and unfolding into a feathered wing motif. LOOK Effects then projected the 2D art onto the moving 3D geometry of Kunis' back, and motion tracked the animation through the hand-held shot. Compositors digitally painted out the tracking markers on Kunis' skin, generated holdout mattes for her bra straps, and used natural skin textures and lighting in the production footage to layer the moving tattoo onto Lily's back.*

and then shot elements with the performers reversing their roles. LOOK Effects generated 2D face replacements, adding Portman's face to the stunt performer's where needed.

As Nina chokes her doppelgänger, the double's neck elongates grotesquely, like a swan's. Aronofsky framed the strangulation with the camera trained on Portman's face, looking over the doppelgänger's shoulder, as Portman clutched a mechanical prosthetic dummy. "I suggested to Darren that we could build a practical stretching neck effect similar to the 'change-o head' effects that Rick Baker devised on *An American Werewolf in London*," related Mike Marino. "Darren loved that idea, so we made a replica of Natalie that had a mechanism inside, and covered that with a very supple, highly plasticized silicone skin. It was a very quick effect, so we used a simple mechanism, like a lever in a caulking gun. We fitted a steel pipe inside the head, anchored to a board, and when we pushed the lever up, the neck stretched."

LOOK Effects augmented the stretching neck with details derived from biological reference. "Darren wanted to see what was happening with the bone and vertebrae under the skin," commented Henrik Fett. "We found some images of a really thin woman and used textures from that for the swan neck's spine, which looked like skin stretching tight over a knuckle. We created that effect in Flame, and then our compositor, Daniel Molina, added strange bony structures pushing through the sides of the neck."



Nina submits to a costume fitting and, while standing between two mirrors, experiences a disorienting vision as she inclines her body to the right, but sees her doppelgänger still standing erect, scratching at its shoulder. Aronofsky filmed the scene with a camera peering through a two-way mirror behind Portman's back. As the actress leaned to the right, the shot tracked swiftly right to left as Portman performed Nina's unnerved reaction. With a greenscreen in place of the mirror, Portman then played Nina's doppelgänger reaching up to her shoulder and glancing back. LOOK Effects layered the elements together in the final shot.

After disposing of her doppelgänger, Nina rejoins the ballet to take her part as the *Black Swan* dances with her lover, the Prince (Benjamin Millepied), in the ballet's grand finale. Aronofsky staged the finale in a lengthy Steadicam shot that circumnavigated Nina as she performed multiple spins, sprouted black feathers from her shoulders and arms, and finally transformed into a bizarre human/swan hybrid.

While Natalie Portman enacted the majority of Nina's dance moves in the film, the complexity of the *Swan Lake* finale required a professional dance double. Sarah Lane, an award-winning soloist with the American Ballet Theatre, performed the dance in 17 takes of the spiraling Steadicam move. Portman then enacted portions of the dance, providing appropriate lighting and intensity of performance for LOOK Effects to digitally graft her face onto close angles of Lane, using 2D composites.

The production filmed the scene on the SUNY Purchase stage, where Curious Pictures erected a motion capture array of 23 Vicon MX40 near-infrared strobe cameras fitted with 12.5mm and 20mm lenses. "The motion capture team calibrated the cameras to handle stage lighting, atmospheric fog effects and ground reflections," stated Dan Schrecker. "We fitted custom motion capture markers to the performer, to the Steadicam rig and the operator. Darren and his crew moved in tow with the



dancer through the scene. We tried to minimize the number of markers we used, which pushed the limits of the Motion Builder retargeting system to drive the performance.”

LOOK Effects previsualization guided the progression of the transformation. “There were three parts to the scene,” Schrecker explained. “The first part followed Nina until she whipped close to camera, where we began to feel the transformation taking hold. In the second part, the growth really started happening on her arms. And then, in the third part of the shot, the camera was behind her, looking out at the audience, and the wings grew all the way.”

The plethora of animated elements blended to the dancer’s body ultimately required extensive hand tracking. “We had originally hoped to use the motion capture data as a basis for our matchmove,” said Michael Capton. “With the dynamic camera, the motion of the dancer, the amount of ground she covered and the way the lighting changed throughout, the data we got out of that was not clean enough for our needs. So we had to do a tremendous amount of matchmoving by hand.”



*The earliest manifestation of Nina’s swan transformation begins as a skin irritation she discovers on the back of her left shoulder. Prosthetic Renaissance designed the rash to resemble the skin of a plucked bird, and created eight styles of Pros-Aide transfer makeup applications that Portman wore in progressive stages through the film.*

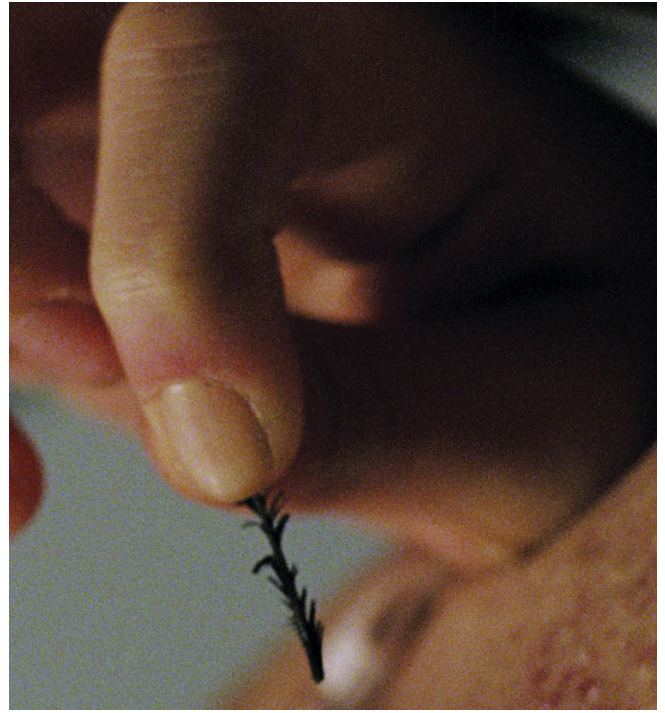


The transformation begins with Nina's fingers, which elongate and spread back into the creature's wings, while black greasepaint on Nina's hands streaks back into the dark plumage. "We tracked 3D elements into the hands and warped the longest parts of her fingers into the wing tips," said Henrik Fett. "As the transformation progressed, we removed the dancer's fingers and transitioned to our feather rig."

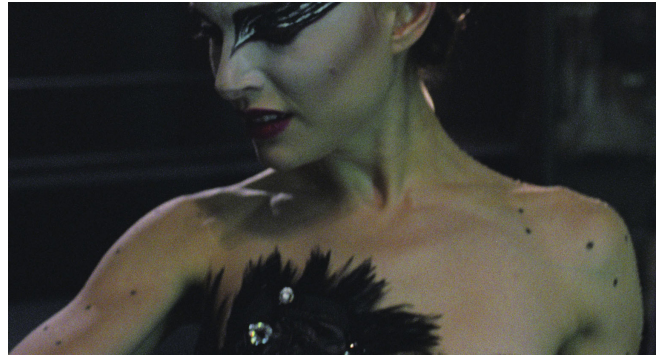
The rig utilized 3D feathers based on feather scans archived online at the U.S. Fish and Wildlife Service Feather Atlas catalog of North American birds. "I used reference of a white tundra swan," explained Shawn Lipowski. "I darkened the feather scans in Photoshop and painted over them to produce a plausible black swan feather. The primary and secondary feathers used curved planes for the barbs and cylindrical geometry derived from extruded curves for the rachides. Each feather had a deformer rig that allowed it to bend in two directions and permitted growth from the rachides. There were ten primary feathers, eight secondaries, and five generic body feathers. We mirrored each set, which gave us 46 feather textures."

Color-coding delineated feather classifications, which LOOK Effects animated to extrude and unfurl using keyframe deformers. "There is a specific way that primary and secondary feathers grow in nature," said Michael Capton. "That formed the basis for how we placed the feathers on Nina's arms and how they grew. Anatomically, bird wings are quite similar to the human arm, so as Nina's hands elongated, her fingers became the primary feathers of her wings."

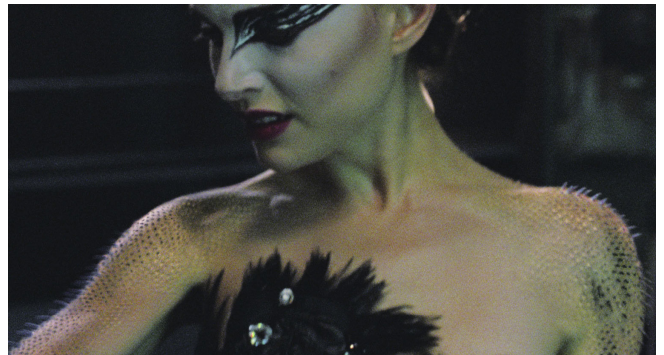
As wing growth reached its final stage, LOOK Effects painted out the dancer's hands and keyframed wings to twist and deform. The dancer's arm motion drove primary wing animation, while the 3D wing rig propelled dynamic interactions across some 11,000 feathers. To light the plumage, Lipowski used high dynamic range images from set to create reflectance maps that simulated shifts in luminance as Nina moved through pools of light on stage. Custom shaders in mental ray gave feathers an oily, anisotropic sheen based on the direction of light reflecting off feather barbs, and subtle qualities of reflectivity and translucency.



*Nina's rash causes her irritation as it develops coarse black spines. Mike Marino's team generated a prosthetic containing real feather pieces that Portman could pluck. LOOK Effects enhanced the effect with animated skin textures and a 3D feather that unfurled between Nina's fingertips.*



Offstage, during the opening-night performance of *Swan Lake*, Nina prepares to fulfill her role as the ballet's tragic heroine by appearing as the black swan. Portman played the transformation scene with a prosthetic rash application across her back and contact lenses suggesting black swan eyes. For the growth of feathers, the production employed a wholly digital approach, utilizing tracking markers affixed to the actress' skin. LOOK Effects then generated rippling skin textures that spread across Portman's arms, creating vestigial feather growth, and oily textures that slid up Nina's arms from greasepaint makeup on her hands.



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LOOK Effects developed multiple passes for color corrections, feather detail, skin textures and streaks of black greasepaint that crept down the dancer's legs. "We provided the 2D artists with as many different elements and layers as possible," remarked Henrik Fett. "That gave them the flexibility to blend between passes, creating subtle changes in how the light played across the feathers as Nina spun around. The shot was so intricate that it required nine 2D artists to composite the various elements."

The camera comes to rest behind Nina, looking out into the auditorium as she raises her wings in a triumphant flourish, backlit by stage lights, and the theater audience applauds. The production staged the scene with no audience in the SUNY Purchase auditorium. Dan Schrecker then oversaw a second-unit shoot with 100 costumed extras, filmed with three cameras, and tiled the crowd to fill theater scenes in successive blocks. LOOK Effects projected those elements onto cards and tracked the audience into the theater, keyed through natural lighting in the plate, and then layered the scene with additional elements of slowly drifting smoke and orchestra members. "Orchestra members were shot against greenscreen, and we composited them into the midground," explained Melinka Thompson-Godoy. "They were far enough out of view that we didn't need to see exactly what they were playing, but it gave a sense of the musicians in the pit."

In a reverse angle, looking at the stage from the back of the auditorium, Nina strikes her final pose, human again, while a spotlight casts her shadow upstage revealing her giant upraised wings. "We used a spotlight to create a practical shadow of Nina on set," said Dan Schrecker. "We knew we were going to add wings later, but we also experimented to see if maybe we should see the full swan neck. Ultimately, we ended up adding just the shadow of Nina's transformed head and wings to the practical shadow, which we repositioned to create a better composition. We also added the audience to the empty theater."



*The black swan transformation progresses as Nina traverses the stage in a lengthy Steadicam shot that spins around her while a lush growth of swan feathers erupts from her back and arms. LOOK Effects previsualized the move and applied animated elements to Portman's dance double using motion capture and hand-tracking techniques, together with color-coded feather classifications. Feather growth was based on studies of swan anatomy, guiding placement of 46 varieties of feather textures. LOOK Effects then generated feather growth, driving procedural interactions of secondary feather dynamics. Dark striations were also animated to spread down Nina's legs.*



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Nina concludes her performance by scaling scenery representing a precipice from which the swan princess flings herself, taking her own life. Portman enacted the swan's fall in a gravity-defying rig that created the impression of the camera traveling with Nina as she fell toward a backstage mattress. "We stood a mattress up vertically on a track with wheels," Schrecker explained. "The camera was on a track and pushed in on Natalie as she stood upright, so she appeared to be flying back into the mattress while the mattress was actually flying towards her." LOOK Effects then stabilized the shot to eliminate camera shake and digitally removed crew members visible in the background.

As Nina strikes the mattress, a wound in her stomach hemorrhages—a result of her fight with her imagined doppelgänger in her dressing room—spilling blood onto her ballerina costume. Mike Marino's team created a closeup section of Portman's abdomen, articulated with a gaping wound that contained a shard of glass. LOOK Effects digitally enhanced the prosthetic and applied additional blood effects. "It was a very expensive ballerina costume," commented Schrecker, "and Darren wasn't sure how much blood he could get away with. So while we were shooting we put a little bit of blood on Natalie's stomach and some red tape tracking markers around that, on her tutu, and we added all the other blood digitally."

LOOK Effects later shot closeup textures of gauze and taffeta soaked with blood. Flame artist David Geoghegan then used the textures to build and animate the bloodstain with trickles of blood expanding across the fabric. For a detailed closeup, LOOK Effects added a jagged 3D glass shard that Nina extracts from her wound. "We replaced and repainted all the gauze," noted 2D supervisor Brad Kalinoski, "and then we added the sheen and more blood to the interior of the prosthetic, replacing the surfaces and warping them in 2D to enhance the breathing effect."

The attention to detail inspired all members of the visual effects team to become collaborators in the project's unique artistic vision. "Darren really challenged our artists in unique ways," noted Henrik Fett. "We've worked on three of his films now, after *The Fountain* and *The Wrestler*, and the multitude of details he requires can sometimes be demanding, but it is ultimately very gratifying to be able to please the eye of someone with that clarity of vision. It always brings out the best in our artists."

Ultimately, *Black Swan*'s balance between disturbing psychological thriller and romantic fairytale required an uncompromising approach. "We needed to create bizarre and gruesome imagery to tell this story," Dan Schrecker concluded, "but it was always realistic. Darren never wanted magical

*feather dynamics. Dark striations were also animated to spread down Nina's legs.*



*As the Steadicam shot comes to rest, Nina arches back in a triumphant flourish at the climax of her transformation. LOOK Effects painted out the dancer's hands for the final stages of wing growth, utilizing arm motion to drive primary wing animation, while keyframe animation made primary featherstwitch and splay. Reflectance maps simulated the play of light and shadow across plumage, and custom shaders created an oily sheen. Compositors added elements of audience and orchestra members keyed through the natural lighting in the plate.*



realism. Even when we got to the final transformation, with the appearance of Nina's swan wings, everything had to feel real. Otherwise, it stopped being scary."

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# Nightmares & Dreamscapes

image

BY JOE FORDHAM

Sucker Punch sprang from the imagination of filmmaker Zack Snyder as a baroque and exotic fantasy, hatched from a life-long interest in graphic art and philosophy. “The idea came from a bunch of influences,” Snyder recalled. “Visually, it came from ideas I’d been working on at Art Center College of Design in Pasadena, where I was heavily influenced by animé. Intellectually, it came from some philosophies I’d been reading from a very early age. The author Richard Bach, who wrote *Jonathan Livingston Seagull*, wrote a book called *Illusions*, which explores ideas about controlling states of reality. I first read that when I was 11 years old, and I’d been toying with those concepts for a fantasy film about striving to control a world that is uncontrollable, and fighting when there’s nothing left to fight for.”

Snyder teamed with a college friend, screenwriter Steve Shebuya, to shape his ideas into a screenplay—set in 1967—about a troubled teenager, known as *Babydoll* (Emily Browning), whose abusive stepfather (Gerard Plunkett) commits her to Lennox House, a desolate asylum for disturbed women. Incarcerated and threatened with a lobotomy, *Babydoll* retreats into fantasy, imagining herself as a courtesan in a stylized bordello, where the asylum therapist, Madame Gorski (Carla Gugino), teaches inmates to use dance to embrace their inner passions. Transported by her imagination, *Babydoll* plunges into deeper fantasies as a sword-wielding warrior, battling adversaries and fighting for her freedom in a series of strange and psychedelic parallel realities.

To realize the heady mix of exotic imagery and adult themes, Snyder and his wife and producing partner Deborah Snyder re-teamed with Warner Bros. and other collaborators from their previous productions. These included executive producer Wesley Coller, film editor William Hoy and cinematographer Larry Fong, along with visual effects supervisor John ‘DJ’ DesJardin, special effects coordinator Joel Whist and stunt coordinator/action designer Damon Caro.

New to the team was production designer Rick Carter, who brought to the show a legacy of modern genre classics, including *Jurassic Park*, *Forrest Gump* and *Avatar*. “I’ve been involved in a lot of very high-quality technical projects,” remarked Carter. “Zack is of another generation, but he’s a kindred spirit to those filmmakers in that he is very free of mind. He is confident as a leader, because of his technical and artistic skills, but he was also courageous in the story he came up with. It drew on many references, like Japanese manga, and it explored themes like Roman Polanski had investigated in *Repulsion*, and Stanley Kubrick had examined in *A Clockwork Orange*—taking viewers to a dangerous place, psychologically. We were intertwining genres to get to a psychological place where anything was possible.”

To realize the world as imagined through *Babydoll*’s eyes, the production used a hybrid of soundstage sets—built at Vancouver Film Studios—and digital extensions, a technique that Snyder had used to impressionistic effect on *300*. “Zack had very skillfully created a heightened sense of hyperrealism on *300*,” observed John DesJardin. “We had a lot of early discussions about that because it can be a tremendous cost savings to pick a look that keeps down the level of

photorealism. We decided not to go that route. Zack wanted to shoot for all the detail we could get, giving him the freedom to manipulate the image later in the digital intermediate. We also decided to shoot on film because Zack knew he wanted to do a lot of slow motion. There are HD cameras now that can handle high frame rates, but we wanted more control using Photosonics cameras shooting 360, 300 and 150 frames per second.”

Fantasy sequences incorporated metaphysical themes. “Zack brought a very painterly attitude to the production,” said Rick Carter. “The first fantasy, where *Babydoll* gets her breath, represented Wind. The second fantasy set in *World War I*, represented Earth. The third, involving a medieval dragon, represented Fire. In the final fantasy, Water ended up being an element that brings the characters back to reality. Those ideas were metaphorical, never overt—and it was way past Jung and Freud.”

The Aaron Sims Company and graphic artist Alex Pardee contributed conceptual designs to develop the film’s look with sketches, 3D art and large-format production paintings. The rapid pace of preproduction required Snyder to depart from his customary practice of personally sketching shot designs, and storyboard artist Lee Hong joined the production to help illustrate action sequences, laying the groundwork for 3D previsualizations.

With only a few months before principal photography, the stunt department joined forces with visual effects to speed the previsualization process. “Zack and I always shoot live-action stunt previz so that on the actual shoot days we are more efficient,” explained Damon Caro. “We figure out camera placement and blocking ahead of time, and get actors involved so we can use stunt doubles less frequently. On this film, the fantasy elements were so huge, we realized that we needed to blend more with visual effects, so DJ and I decided to put together previzes that intercut with elements from his world.”

Dubbed ‘techviz,’ the combination of stunt test video and 3D animatics became an important template that allowed the production to clearly envision how performers could interact with largely virtual worlds in a creative give and take. “There can sometimes be competition between stunts and visual effects,” commented John DesJardin. “From a visual effects point of view, we often feel we can help with safety issues; and in some cases that means taking over shots. I didn’t want to do that. I wanted to help Damon accomplish his stunts by breaking shots into sections, so he could make the physical parts safer, knowing that he could pick up the shot later, continuing the action from our CG moves.”

Fight rehearsals began at Caro’s studio in Los Angeles with the stunt team and three available principal performers, including Emily Browning, who trained with her stunt double, Heidi Moneymaker, a former gymnast. “We took the girls through basic stance training and a diverse repertoire of Chinese, Filipino, Thai, Japanese and Western martial arts and boxing methods,” stated Damon Caro. “They had weapons training for long-guns and handguns, and we taught them the basics of punching, kicking and throws. While they were building their foundations, we refined our choreography and worked them in, building their technique and stamina so Zack could shoot them in longer shots with a perfection and beauty to their action.”



For fight maneuvers requiring wire rigs, stunt specialist James Churchman supplied custom computerized winches, air rams, ratchets and accelerators. “Our goal was to hide rigs from camera,” noted Caro. “We used waist harnesses whenever possible, but we sometimes needed flying vests, which were more of a challenge to hide under the girls’ skimpy costumes. In those cases, we’d either wrap the actor with skin-tone dance wrap, or our visual effects brothers helped us out.” Rig removal was necessary for elaborate moves where harnesses employed up to eight cables. “If we had to fly somebody in multiple directions, we used various different wire setups and picks. One such setup is a ‘double-V’ pick. That consisted of two lines from the front of the hip, and two lines from the back of the hip, creating a ‘V’ on their right and a ‘V’ on their left. And then we might need a tag line to guide them.”



*Babydoll (Emily Browning) and her stepfather (Gerard Plunkett) arrive at Lennox House, an asylum for disturbed women, where Babydoll is incarcerated and threatened with a lobotomy in Sucker Punch. Director Zack Snyder conceived the film as an exploration of metaphysical themes of self-empowerment coupled with excursions into animé-styled fantasy. Production designer Rick Carter and visual effects supervisor John DesJardin brought to life settings, both real and imagined, on soundstage sets enhanced with digital extensions furnished by four main vendors, including Prime Focus, which generated the Lennox House introduction.*

While stunt training continued in Vancouver, Quantum Creation FX tested makeup effects, which featured most notably in *Babydoll*’s third adventure set in a medieval castle. “We ended up making more than 100 orc demon makeups,” commented Quantum Creation makeup effects project producer Christian Beckman. “They were based on five or six different sculpts. A group of stunt guys played knights, and then turned around and played orcs and other characters. So we lifecast them and made specific appliances for them. During heavy days of shooting, we had as many as 30 orcs in a scene.” Quantum makeup artists designed generic orc makeups to fit multiple performers, and then differentiated the orcs’ appearance using individualized paint schemes. Before performers were available for lifecasting, Beckman created a prototype orc makeup to test the creatures’ aesthetic movement and skin tone. “We already had my lifecast, so I figured let’s use that, and we created an orc makeup and generated prosthetic pieces in foam latex. In Vancouver, we did a full-on film test. Zack directed me while I was in orc makeup and costume, and that gave the production its first look at how the creatures would appear on film, after they added their digital image treatments. Much of our color palette and orc reference was based on lizard skin textures and amphibian colorations.”

To generate digital assets, John DesJardin and visual effects producer Tamara Watts Kent selected four visual effects vendors to handle one fantasy each. The Moving Picture Company focused on *Babydoll*’s first warrior encounter fighting giant samurai, Pixomondo handled *World War I*, Animal Logic tackled the medieval episode, and Prime Focus handled the opening of the film and *Babydoll*’s final adventure on a futuristic train. Digiscope handled additional composites.

All vendors shared digital doubles of the four main protagonists built from on-set data capture sessions that included Gentle Giant Studios scans and lidar surveys. “We had a cyberscan setup in

tents and funneled everybody through,” explained John DesJardin. “In the first tent, Gentle Giant set up their equipment. In another, our visual effects coordinator, Shandy Lashley, processed all the actors, stunt people and extras. He stood each one on a turntable, with a couple of Kino lamps creating flat lighting, and shot polarized and non-polarized high-rez stills that we used for building textures.”

Lashley also rigged and manned a portable orthogonal camera array, which the production used in tandem with high definition video witness cameras to grab texture reference on set. “I didn’t want to go through big performance capture sessions in post,” stated DesJardin. “We weren’t trying to recreate actors delivering dialogue; this was all about them fighting. So rather than sitting Emily in a chair and surrounding her with cameras, I wanted to point a bunch of cameras at her, all synced, and go ‘click’ as she struck a pose, which would give us super high-rez data for our transition sections.” The hand-held camera array—dubbed the ‘Shandycam’—involved six DSLRs bolted onto a Speedrail assembly. “We had one camera in the middle, two flanking that at approximately 45 degrees, another lower down, and two on either side of that taking overlapping images. After Zack yelled ‘cut,’ if he liked the take, Shandy positioned his rig where the film camera was, set the focus, and when he hit the shutter release, it automatically shot bracketed exposures. That enabled us to capture actors in the moment. We didn’t have to come back months later, put Emily in a vacuum, and shoot elements that we had to light our way into. It was our safety net, and we used that a lot.”

A theater proscenium opens the film with velvet curtains that part to reveal a female figure on stage kneeling on a bed with her back to the audience. As the camera approaches and swings around to reveal the girl as *Babydoll*, the theater has vanished and *Babydoll* is seated in her bedroom. Prime Focus started with photography of a full-scale theater frontage set, and projected the plate onto theater geometry, which seamlessly blended into footage of *Babydoll* on her bed. “We shot a Technocrane move up onto the stage,” John DesJardin explained. “As the camera moved around Emily, we slid a greenscreen in behind her so that by the time we were looking back at her face, the greenscreen was behind her. We then shot footage of *Babydoll*’s bedroom and elements of rain falling outside her window, and comped those in.”

*Babydoll* witnesses her stepfather attempting to seduce her younger sister (Frederique De Raucourt) in a dramatic sequence that involved the camera traveling through a keyhole to arrive at a reflection in *Babydoll*’s eye. “We digitally rebuilt the door to get our camera to go through it,” related Prime Focus visual effects supervisor Bryan Hirota. “DJ gave us a macro shot of Emily’s eye. We added reflections, and then the camera passed through that to enter the reflection.”

When *Babydoll* attempts to protect her sister, her stepfather lashes out and rips at her blouse. Prime Focus enhanced the action by digitally removing a practical airborne button, and replacing it with a CG replica that speed-ramped into slow motion. For an ultra-low angle of the button hitting the floor, property master James Chow supplied an oversized prop to facilitate a forced-perspective illusion. “We shot that in-camera,” revealed John DesJardin, “with a button the size of a Frisbee, being careful how we framed it so the floor did not look out of scale.”



Zack Snyder uses a Nikon D300S, with a custom focus screen and a handheld mount that video assist operator Dave Joshi assembled from a variety of DSLR rigs, to plan a sweeping crane move within the Lennox House recreation room. Snyder and director of photography Larry Fong elected to shoot the production on film, facilitating slow-motion speed-ramping effects, but Snyder relied upon digital cameras to previsualize sequences. The footage, developed hand-in-hand with the stunt department and visual effects, allowed the filmmakers to assemble ‘tech-viz’ playback that guided filming of complex action scenes designed to interweave real and virtual elements.

*Babydoll* aims a pistol at her stepfather to hold him at bay; but, in the ensuing struggle, the weapon discharges, one bullet shattering a light bulb and another killing her sister. Special effects provided the exploding light bulb as another stylized in-camera effect. “Zack wanted the exploding light bulb to be a very high-speed shot,” recalled Joel Whist. “We took a normal household light bulb, fitted a smaller light bulb inside, and rigged the internal lamp to a 12-volt power supply. We machined a bullet out of Delrin, and painted that to look like copper with a lead slug tip. We then cut off a rifle barrel and rigged it with air so it could shoot the Delrin bullet at about 150 psi.” Pneumatic pressure jettisoned the lightweight dummy bullet at much slower speed than a real bullet, but with natural spin, allowing a Photosonics high-speed camera to capture the projectile as it struck the breakaway bulb, filmed at 600 frames per second.



At Lennox House, *Babydoll* experiences a series of fantasies in which she envisions herself first as a courtesan in a fancy bordello. Then, during a dance rehearsal, she slips into a further dream-state where she imagines herself as a warrior-in-training in ancient Japan. Browning performed the introduction to the Japanese fantasy in a soundstage set that included a courtyard floor that special effects supervisor Joel Whist’s team dressed with a scattering of fake snow. The Moving Picture Company then generated digital set extensions of a giant pagoda and stylized snowflakes that drifted lazily around *Babydoll*.



Held responsible for her sister's death, *Babydoll* is pronounced criminally insane, and her stepfather drives her to Lennox House, angling to extract an inheritance after *Babydoll*'s lobotomy. Prime Focus generated an epic, 50-second-long crane shot that had the camera descending through clouds to reveal the stepfather's car surrounded by countryside, moving to a closeup of *Babydoll* in the passenger seat, revealing the main title of the film formed in raindrops on the window, then pulling away to view the distant Lennox House. Production filmed actors in the car on a greenscreen stage as a Technocrane jibbed down and prowled around them. "We used the interior of the car and the actors seen from the front and the side," said Bryan Hirota. "The rest of the time, the car and the occupants were CG. The exterior of the car was always CG, and the environment was all CG. We built the road, hill, trees, all the grass around them, and Lennox House."

Rick Carter based the Lennox House design on reference of the Biltmore estate in Charlottesville, North Carolina. Prime Focus translated conceptual designs into a 3D model, with Autodesk Maya Paint simulations of grassy fields. To create the main title graphic in water droplets on the car window, Alex Pardee generated artwork of the stylized title font. Prime Focus used the art to guide the flow of 3D droplets, with refraction and reflection. For shots of the car arriving at Lennox House, production built a portion of the courtyard as a 100-foot-square set lit with Ultra Light Space Lights to create an even top-light. Joel Whist's team added atmospheric effects of mist and rain, which Prime Focus augmented with CG rain particles and set extensions.

In the asylum, *Babydoll* experiences a perceptual shift as she is prepared for her lobotomy, retreating into her fantasy of an exotic bordello. The moment of transition evolved in postproduction from an earlier scripted sequence that interwove flashbacks to *Babydoll*'s home life. "I had originally conceived the opening of the film as a flash-forward and flash-backward," recalled Zack Snyder. "When I showed the first cut to some friends, they had trouble following it, so we made it more linear, going from *Baby*'s home, to the asylum, right into the moment where she's about to be lobotomized. As the hammer strikes the lobotomy tool, it brings us into another reality. The rest of the movie takes place in that moment, like *An Occurrence at Owl Creek Bridge*."

The original scripted transition from asylum to brothel occurred in a lingering pan around the institution's recreation room. Camera operator John Clothier performed three non-motion-control repeat moves, with the assistance of video coordinator Dave Joshi. The first take panned around the asylum hall to Gorski coaching Sweetpea (Abbie Cornish) on



*Across the pagoda courtyard, a trio of 12-foot-tall samurai warriors appears and engages Babydoll in hand-to-hand combat using a variety of weapons. MPC generated the samurai as CG characters based on conceptual art by The Aaron Sims Company and historical reference. Modelers fashioned the characters using muscular body forms clad in digital re-creations of ancient samurai armor built from wood, fabric and leather. Samurai garb incorporated traditional Japanese weaponry and ornamentations combined with modern machine guns and rocket launchers.*





the stage. The second began in similar position on the bordello set, then panned to Amber (Jamie Chung) pulling a rubberized strip of paint from the wall, revealing lush wallpaper beneath, leading into the bordello hall with Babydoll and other inmates in stockings and suspenders. A third take then revealed Babydoll on stage in bedroom attire, kneeling on the bed. Prime Focus blended the three plates into one 440-degree pan, creating the illusion of the dingy hall slowly transforming into the 'Paradise Club.'

*Stunt coordinator Damon Caro worked with stunt performers and Emily Browning to choreograph action. Snyder, Caro and DesJardin visualized portions of the fight that required digital doubles, and devised an approach to suggest Babydoll's tiny stature in relation to the samurai. MPC ultimately animated the samurai using both performance capture and keyframe animation to re-scale warriors to towering proportions. Browning's stunt double, Heidi Moneymaker, squares off with samurai performers – stuntmen wearing marker bands to assist tracking – during a motion capture session.*

The filmmakers ultimately incorporated only the latter part of the shot into the revised opening. Brothel action instead begins in the dance rehearsal room, where Gorski coaches her student-inmates and Babydoll enters her first fantasy-within-fantasy in a transition to a courtyard beside a Japanese pagoda.

Snyder shot the pagoda transition in two parts, moving in and out on Emily Browning. MPC then generated a transition between the 'A' and 'B' plates, utilizing footage of Browning's eye to create a super-detailed blink. "We had Babydoll in the dance hall with the camera zooming a little bit onto her face," explained MPC visual effects supervisor Guillaume Rocheron. "We had the same shot reversed with her on greenscreen, in the pagoda lighting environment, with a 180-degree move around her. DJ used a Photosonics camera to shoot extremely closeup macro-photography of her eye opening and closing. We projected the textures onto a 3D model, and rendered that with a 3D camera move." The transition was complicated by varying speeds in Browning's eye motion and the position of her cosmetic eyelash extensions. MPC rendered CG patches to blend between the plates, and used matchmove data to animate interactions as a snowflake lands and melts on one eyelash.

Babydoll's ultra-glamorous look—devised by makeup department head Rosalinda Da Silva—put extreme demands on MPC's digital texture team, which spent months developing an equivalent digital double skin shader. "We usually try to make CG human skin look realistic by adding tiny imperfections," commented Rocheron. "Babydoll's skin had to be perfect, but it was very difficult to avoid her looking plastic with so little detail in the texture maps. We put in some details, but then our look-dev artists spent weeks dialing down the skin tone, fine-tuning skin color response, and playing with subsurface scattering, which behaved very differently through Emily's makeup. Having a fair amount of full digital shots and CG takeovers, we went through meticulous adjustments on a shot-per-shot basis."

Snyder shot Browning in a 40-by-80-foot courtyard set, which Joel Whist's team dressed with a mix of polymer and paper snow. MPC then added digital set extensions and Maya particle animation of stylized 3D snowfall. "Zack wanted to play the gentle descent of falling snow against the action," stated Rocheron. "We built some very detailed 3D snowflakes and slowed them down quite a lot, which added more detail than you would see in real life."

MPC lighting lead David Hirst lit the pagoda using a Pixar RenderMan volumetric lighting shader developed to emulate atmospheric light diffusion and attenuation. Environment artists built distant 3D mountains and trees, and a detailed 3D wooden temple. The shader then rendered volumetric

haze and computed light attenuation to create atmospheric densities and shadows. The pagoda interior set consisted of a stone tiled floor and a rack of candles. MPC created 3D extensions of wood beams and ornamental banners suspended from the ceiling, and used global illumination techniques to create a cavernous candlelit interior by layering in smoke and dust.

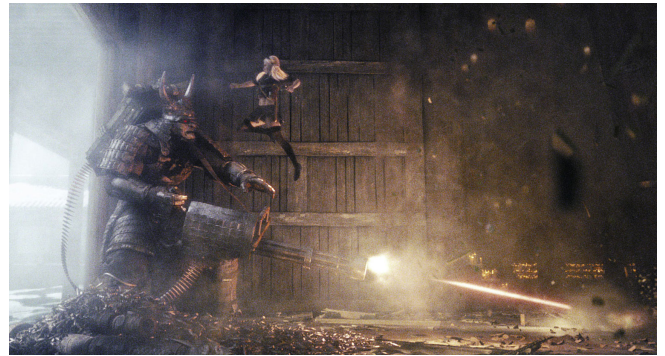
A mysterious figure, known only as Wiseman (Scott Glenn), presents *Babydoll* with pistols and a samurai sword, which she uses to face off with three 12-foot-tall samurai. The stunt team and visual effects departments put together a six-shot test, juxtaposing Emily Browning's five-foot-two height with stunt performers on raised platforms to affect appropriate eyelines. "Proportionally, it looked right," said John DesJardin, "but the stuntmen couldn't move correctly. We realized it wasn't so important for *Babydoll* to be looking at her opponent's eyes, anyway; she was more focused on the business end of the weapon attacking her." DesJardin used a cutout on a C-stand to guide eyelines, while a stunt performer performed samurai moves at ground level. MPC shot the test with three Canon 5D Mark II cameras in video mode, assisted by HD witness cameras. The HD footage provided digital double reference and blocking data for animated samurai, which MPC animation supervisor Daryl Sawchuk and his team scaled to the desired 12-foot height.

Visual effects editor *George McCarthy* prepared techviz of fully realized fight choreography intercut with MPC's previz, and superimposed red 'X's across scenes envisioned as pure animation. The production team then referenced techviz playback on set. To assist motion tracking, stuntmen wore marker bands around their arms, crisscrossing their chest and back and circling their waists, thighs and lower limbs, with boots, gloves and caps. MPC synced HD witness cameras with time-codes, while Larry Fong ran film cameras at 96 frames per second.

To create CG samurai, MPC studied historical reference of ancient Japanese armor. "Historically, samurai armor was made of leather, ropes, strings, and sometimes wood," noted Guillaume Rocheron.

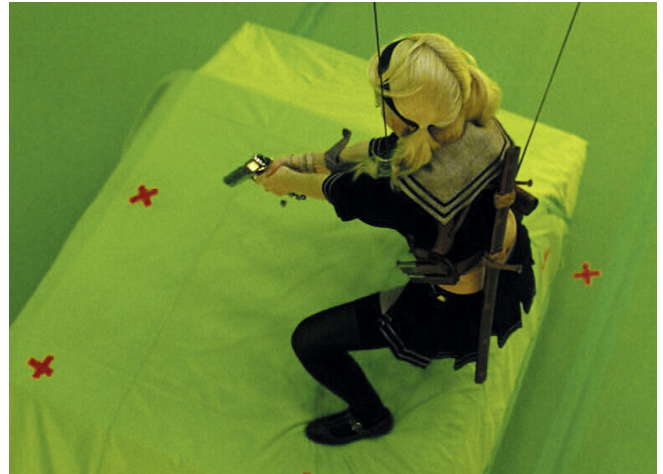
"They had to be flexible because they needed to move very fast in sword fights. Our samurai had to burst through doors, do giant leaps and other very athletic moves, so we spent a lot of time rigging how the armor would articulate and fit." MPC modeling team lead Chris Uyede and texture lead Rebecca Melander outfitted each warrior with more than 300 texture maps, ranging between 4K and 8K resolution. Samurai accouterments included a sword-and-spear combo 'spord,' a Mark 153 Shoulder-Launched Multipurpose Assault Weapon, and an M134 Dillon Aero Gatling gun with ornamental engravings, and rigid-body simulations of flying shell casings.

Effects of bullets tearing into timbers required an overhaul of MPC's physics dynamics engine, Papi. "Wood has a very particular shape when it breaks," noted Rocheron. "It splinters around fibers, creating a lot of detail. Rigid-body simulations use shattering effects based on geometric Voronoi



*Inside the pagoda, Babydoll shows superhuman athletic skills by defeating the first samurai and attacking the second in a running leap. Heidi Moneymaker and Emily Browning both performed reference of Babydoll's action using a wire rig. MPC then created a digital double of Babydoll, derived from body scans of Browning and high-definition still photography, and generated the entire wide shot digitally. Environment details included simulations of shattering wooden beams, burning cloth banners and flickering candles layered with smoke and dust, 3D muzzle flashes and flying shell casings.*

equations. Those are perfect for breaking rigid objects like rock or concrete; but we had a lot of slow-motion shots of wood bending and splintering, so that required a new solution.” MPC research and development lead Ben Cole integrated a videogame technology—Pixelux Entertainment’s DMM—a real-time physics simulation engine that used finite element analyses to simulate malleable fracturing effects. “Finite elements take into account the material properties of how an object breaks. They simulate surface tension and analyze the resistance of how an object bends, stretches and snaps.” The approach led MPC to develop a new destruction toolkit, Kali. Effects lead Harry Mukhopadhyay and his team used Kali to simulate material properties of bending metal, shattering wood and cracking stones at very high resolution. The simulations took into account objects’ underlying structures, but kept events controllable by implementing keyframe-animated driver objects.



*Babydoll vaults onto the samurai’s chest and unloads her handgun into its face, causing it to fall backward. Damon Caro’s stunt team provided a greenscreen form to simulate the samurai’s body, onto which Browning could leap wearing stunt lines attached to a hip-mounted harness concealed beneath her costume. MPC digitally erased stunt rigging, tracked Browning’s performance and animated the samurai’s reaction. Modelers detailed the warrior model with texture maps capable of withstanding close scrutiny, and articulated the creature’s costume with rigid armor pieces interspersed with cloth simulations and stitching.*

Mayhem begins when the first samurai kicks *Babydoll* backward into the pagoda and then smashes through the heavy wooden doors. Damon Caro initiated the action with Heidi Moneymaker ratcheted backward. MPC then used a digital double for *Babydoll*'s airborne journey, impacting a rack of candles and crashing to the ground. The digital double's velocity—spanning 30 meters in ten seconds—required special controls for *Babydoll*'s hair, slowing down physics simulations to artistic effect. Moneymaker performed the landing, pulled backward into a shallow trough. Browning then completed the recovery, miraculously unharmed.

Cloth banners catch fire and continue to burn as the fight progresses. Larry Fong used flame-bars to create interactive firelight effects on *Babydoll*. MPC 2D lead Mark Curtis and his team then rotoscoped Browning and relit portions of her body to enhance flicker effects. The proliferation of camera speed ramps and slow-motion shots required custom dynamic fire simulations. "We worked out the details of our animation and simulations at 96 frames per second," said Rocheron. "We then sped the action up to 24 frames per second to review the dynamics and rhythm of the shots. Every time we submitted a shot to DJ, we gave him a high-speed and a standard-speed version. The high-speed version then went to editorial where they did their speed ramps and re-times. We processed that back into our 3D re-time pipeline to apply the re-time information at render time, in RenderMan, which gave us accurate interpolations and motion blur."

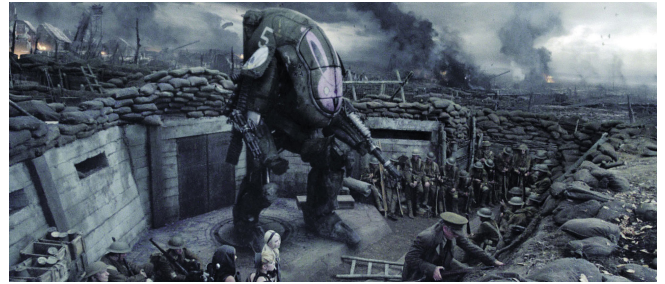
*Babydoll* matches the samurai in combat, defeating the first warrior and then attacking the second, leaping over machine gun tracer fire. Heidi Moneymaker used a wire rig on a boom arm to perform action of *Babydoll* attacking the machine gun samurai in a running leap. Emily Browning repeated the move in the same rig to provide performance reference. MPC then generated the master shot of *Babydoll* vaulting onto the samurai's body in an entirely CG shot. Browning performed subsequent shots, unloading pistol rounds into the samurai's face. "We had a mockup of the samurai's shoulder for when Emily jumped up and cocked the gun back in the air," noted Damon Caro. "As the samurai fell back and she traveled down with him, visual effects took over. We shot a couple of pieces for that as *Baby* fired the gun. After he landed, Emily stepped off another mockup of the fallen samurai."



*Babydoll vaults onto the samurai's chest and unloads her handgun into its face, causing it to fall backward. Damon Caro's stunt team provided a greenscreen form to simulate the samurai's body, onto which Browning could leap wearing stunt lines attached to a hip-mounted harness concealed beneath her costume. MPC digitally erased stunt rigging, tracked Browning's performance and animated the samurai's reaction. Modelers detailed the warrior model with texture maps capable of withstanding close scrutiny, and articulated the creature's costume with rigid armor pieces interspersed with cloth simulations and stitching.*



MPC animated the samurai's fall, using the warrior's mass to drive motion of the CG *Babydoll*. "We had to plant her feet onto the samurai and let gravity work," explained John DesJardin. "That's the way we chained the animation in our test. Zack then decided how cool *Babydoll* should be as she stepped off. He directed her to be totally badass. She just lands and steps off, in mid-stroll. Then we used the Shandycam to grab Emily's end position as she struck her fighting pose." MPC used the reference and film footage to create a slow-motion full-frame transition, matching *Babydoll*'s digital face, clothing and hair to the plate over 15 frames. "Emily is entirely CG until after the samurai lands. At her first step off, we transitioned to Emily's real face and upper body, but kept her CG legs. From that point on, as she stepped onto the ground and walked toward camera, that was all Emily."



*Babydoll* next recruits four asylum inmates to join her in a shared fantasy in which the five young women become warriors in a surreal World War I combat zone where they encounter the 'mecha,' a futuristic armored endoskeleton. The production built a portion of the war zone as a network of trenches backed by greenscreen, and provided a greenscreen framework to represent the mecha. Pixomondo created digital environment extensions and generated the mecha as a keyframe character emblazoned with a pink bunny emblem in reference to an artifact from *Babydoll*'s long-lost home life.

Behind *Babydoll*, the pagoda collapses. MPC generated the slow-motion crashing timbers as driver objects in Papi and then applied more complex simulations in Kali. "It would have been very inefficient to run finite elements for the entire pagoda," explained Guillaume Rocheron. "Instead, we built a low-resolution model, cut it into different sections, and ran rigid-body sims of that geometry to create quick visual feedback in Papi. Those simulations drove our high-resolution finite elements solve. It was an extremely useful way to create a spectacular effect."

As the final samurai prepares to battle *Babydoll*, she conjures a zero-gravity field around her and cuts the giant down in a blur of swordplay inspired by Katsuhiro Otomo's anim  classic, *Akira*. "Zack asked us to make an *Akira* power bubble in the snow," said Rocheron. "At this point in the story, *Babydoll* realizes that she has super powers, so she creates a zone of anti-gravity. Snow on the ground and falling snow get picked up in that energy field, and as the samurai runs towards her, she does a huge jump. It's a very manga moment." MPC generated subliminal flash-cuts of CG crows taking wing, a feather and a closeup of an eye as the last samurai falls dead.

Empowered by her experience, *Babydoll* enlists four inmates to help her steal a map of the Lennox House, plotting her escape via another fantasy. The fantasy begins with a shot that circumnavigates *Babydoll*, passes through a dance rehearsal mirror and then reveals a *World War I* battlefield. Snyder created the journey through the mirror with actor doubles either side of a double set representing a fake reflection. “We began looking past Emily into the fake mirror,” related John DesJardin. “The camera went past the back of Emily’s head toward her body double. We stood two twins in midground either side of a double handrail, so it looked like we were seeing them reflected, too. The camera then crossed into the reflection and came back around to *Babydoll* who suddenly had new wardrobe and weapons. Then we pulled back and revealed the *World War I* landscape in front of her.”

Pixomondo assembled the shot from two plates—one of Browning in dancehall attire, and a repeat take of her in warrior mode, filmed without motion control—and then blended between them. “When the camera passed into the mirror,” related Pixomondo visual effects supervisor Rainer Gombos, “we added a plane of dirt so it looked like we were going through the mirror surface. We roto-scoped Emily, matchmoved her in the two plates, did a lot of paint fixes to rebuild portions of the background, and then used digital projections to create transitions.” The choreography of the shot, rotating tight around Browning’s head, allowed Pixomondo to subtly introduce wardrobe changes, revealing a hair band behind her braid and the hilt of *Babydoll*’s sword as it came into view over her shoulder. Other details required compositing tricks. “To transition between her hairstyles, we tried warping between plates, but that created too much movement. Instead, we projected texture patches with color corrections, and then transitioned to the war zone lighting.”

The *World War I* environment involved extensions of burnt vegetation and rubble with explosions,



*Babydoll* and her team enter enemy territory and run into mutated German stormtroopers with steam-powered mechanical faces. Quantum Creation FX created stormtrooper makeups as prosthetic applications on stunt performers, with radio controlled appendages and breathing mechanisms. Pixomondo later enhanced the characters with additional spurts of steam that vented from their bodies when pierced.



Quantum Creation also provided a disfiguring burn makeup for an evil German colonel (Richard Cetrone),



billowing smoke, barrage balloons, biplanes, flak and tracer fire. Central to the environment was a ruined cathedral with a familiar outline. “We tried to make connections so whatever was in one world had a reflection in the next,” said Rick Carter. “The inside of the *World War I* cathedral was reflective of the asylum rehearsal hall. And the front was an iconic structure reflecting Lennox House. Then we built a network of trenches that were reminiscent of the asylum hallways.”

*which incorporated silicone pieces, detailed with translucent paint effects and custom hairpieces.*

Pixomondo CG supervisor Boris Schmidt and 2D supervisor Stuart Cripps created cathedral set extensions and filled the sky with biplanes engaged in dogfights, anti-aircraft explosions, tracer fire and airships. Pixomondo art director Thilo Ewers supplied concept paintings to help visualize the battlefields. Barrage balloons were modeled as 3D objects and animated with cloth simulations. Cameraman William Dalglish photographed elements of cloud tank liquid injections that Joel Whist’s team created using submerged incendiary squibs, but Pixomondo digital effects supervisor Sven Martin generated the majority of cloud elements digitally for adaptability. Ground-level explosions were combinations of practical elements and CG simulations.

After receiving their mission briefing from Wiseman, *Babydoll* and her colleagues descend into the British trenches where they find an armored bipedal exoskeleton—the ‘mecha’—that Amber climbs into. The art department constructed a greenscreen framework for Jamie Chung to board on set, as well as an interior cockpit set with opening and closing doors. Pixomondo generated the mecha exterior based on an art department maquette painted with an incongruous pink bunny decal representing *Babydoll*’s sister’s stuffed animal. Pixomondo keyframe-animated the mecha to open and close around Amber, sealing her inside, and textured the 3D model with battle damage. For interior views of Amber working mecha controls, computer graphics video playback supervisor Gladys Tong generated graphic projections reflected onto Chung’s face. Pixomondo’s motion graphics division in Frankfurt, Germany, designed an interactive heads-up display timed to the practical illumination.



*A German Gotha bomber flies over a ruined cathedral where *Babydoll* and her team receive their mission briefing from a mysterious character named Wiseman (Scott Glenn). Rick Carter designed the cathedral as one of several key structures in *Babydoll*’s fantasies designed to reflect the outline of the Lennox House asylum. The production built a portion of the cathedral as a soundstage set adjoining the trenches. Pixomondo then extended the environment as a detailed 3D model surrounded by a ravaged landscape filled with rubble, explosions and anti-aircraft fire.*

*Babydoll* leads an assault on the German front line, but the young women run into a squadron of imposing stormtroopers with steam-powered mechanical faces. “Zack and Deb didn’t want R-rated blood splatter everywhere,” noted John DesJardin, “so all of *Babydoll*’s fantasy opponents were non-human. The German soldiers venting steam were already dead.”

Quantum Creation created zombie-like cowls, gas masks and helmets for 20 German infantrymen. “We had a couple of hero-version stormtroopers that had mechanical masks with six or seven functions in the face,” related Christian Beckman. “The eyes could open and close like a camera iris.

Beneath that were Lightwire filaments that lit up like old-school light coils. They had gears in the forehead, and a breathing apparatus like a plunger that opened and closed, emitting smoke—those were all radio-controlled functions that we could perform whenever Zack requested them. And then we had midground versions and stunt versions.”

Costume designer Michael Wilkinson oversaw stormtrooper costumes from the neck down and supplied Quantum with period German combat helmets. Quantum lead mechanical designers Tim Ralston and Mecki Heussen then created mechanized additions. “We cut the helmet apart and enlarged it to accommodate the larger mechanical masks,” explained Beckman. “We made a vacuform buck from that and generated the helmets. We made a leather hood with a zipper in the back that attached to the mask, and modeled pieces that we cast in resin and painted with a metal finish. We used a couple of found items—old camera irises and small canvas-covered hoses—but 97 percent of the masks we built from scratch. For the venting steam, Tim Ralston built little radio controlled oil crackers, with mineral oil in canisters that the soldiers carried on their backs. Tim rigged those to a push-button remote, so we had ten infantry guys, all controlled remotely on a little clicker.”

For trench combat, the props department supplied German bayonets with retractable blades, while special effects rigged dust impact squib hits and practical gun flashes. “The actors rarely fired real blanks,” noted Joel Whist. “We only did that when there was one person in a shot. For other scenes, we simulated muzzle flash reflections using a diode system mounted to the side of weapons. It was like a glorified Maglite machined out of Delrin and fitted with a cluster of LEDs, with a micro-switch at the trigger. We had different versions for pistols, rifles, shotguns and machine guns that we could dial up or down in frequency. We velcroed those to guns and they created flashes on the girls’ faces, the environment and the people they were shooting.”

Pixomondo corrected flicker timings, painted out vis-ible lighting modules, and tracked muzzle flashes to weapons using practical and CG elements. Other digital enhancements included CG steam emanating from stormtrooper wounds, and laser light effects tracked into stormtrooper eye sockets.

Babydoll infiltrates a German bunker and falls captive to an evil colonel (Richard Cetrone). Quantum Creation FX built and applied a silicone makeup for the colonel, creating a disfigured burn effect with a clammy sheen achieved with translucent paint effects and clear gels.

Fighting the colonel, Babydoll is slammed into a bunker roof support, causing a cave-in. The special effects team created the bunker collapse using squib-controlled breakaway effects. The effects team first installed a pre-scored beam laminated with rubber on the impact side for Browning to hit, and



*Operating the mecha, Amber (Jamie Chung) opens fire on a German zeppelin bearing down on her and her companions as they cross No Man’s Land. Pixomondo used an art department maquette, together with historical reference, to construct a gigantic digital zeppelin, detailed with a fanciful array of fixtures and armament. The No Man’s Land environment required extensive digital dressing to expand the stage set, layering the landscape with greenscreen elements of advancing German soldiers, practical explosions, digital fire and smoke plumes, flak and barrage balloons.*



then rigged a second beam to split. “We pre-broke a hollowed-out cedar beam,” said Joel Whist. “We hinged fingers of wood to slot together, sealed the cracks with Plastalina modeling clay and then, when Emily hit, it released. For the collapse, we pulled the beam back with a ratchet. The ceiling beams were balsa and cedar, with sandbags, peat moss, gypsum and fly ash above. Nobody got hit, but we positioned those with Damon to make it look like the colonel was taken out.”

Babydoll pursues a German soldier, grabbing a large machine gun to prevent his escaping on a zeppelin. Emily Browning fired the machine gun using an overhead track that Whist’s team rigged to suspend the hefty weapon on a counterweight. Pixomondo digitally erased wires, added environment enhancements and generated the departing airship. “We referred to an art department maquette and real zeppelins,” said Rainer Gombos. “We added pennants, cables, guns, railings and crew. We made the engines quite elaborate and added a giant cockpit with windows.”



*Weapons fire causes the zeppelin to burst into flames and crash to the ground. Special effects staged pyrotechnic burn elements, igniting black paper panels to simulate the surface of the zeppelin catching fire and shriveling in the conflagration. Pixomondo used the elements as reference, and generated digital fire and smoke interacting with the zeppelin’s framework, revealing internal structures that crumpled as the enormous airship struck the ground. Compositors then layered the scene with foreground architecture, fleeing infantrymen and burning debris, and with background details of swooping biplanes, fire and smoke.*

Machine gun fire causes the airship to burst into flames. Joel Whist staged pyrotechnic burn elements with black paper panels, including a 20-by-20-foot section ignited using Mapp gas. Pixomondo’s Berlin studio used the elements as reference, and 3D lead Mohsen Mousavi applied digital fire and smoke across the zeppelin structure using Maxon Thinking Particles, Sitni Sati Fume FX and Afterburn, and Pixomondo’s in-house fluid simulation engine.

After retrieving a map vital to their escape, *Babydoll* and the girls navigate No Man’s Land, with Amber in the mecha providing covering fire. The production filmed No Man’s Land scenes in a minimal set, which Pixomondo expanded to the horizon with 360-degree digital environments, smoke and atmospheric effects.

Angered by an explosion that dislodges her lollipop, Amber fires jets in the mecha’s feet that launch her skyward to engage enemy aircraft at close range. Pixomondo generated the flying mecha and aircraft, including SPAD biplanes and a giant Gotha bomber for an aerial clash. The mecha lands and squashes the last of its attackers, leaving *Babydoll* free to return home in a swift transition that Pixomondo created between two plates: one of Emily Browning closing her eyes in *World War I*, and another of her opening her eyes in the dance rehearsal room.

The third fantasy begins during a dance number in the Paradise Club, where *Babydoll* dances on stage as Amber attempts to steal a lighter for use in their escape. A gust of wind blows *Babydoll*’s hair, signaling a transition to a *World War II* bomber with modern machine guns, one prop engine and one jet engine, circling a medieval castle.

The bomber design began as a model kit maquette based on a Mitchell B-25. The art department replicated the aircraft as a full-scale set of the fuselage, minus wings, with a separate cockpit. Joel Whist’s effects team mounted the fuselage to a motion control gimbal. Animal Logic animator

Cameron Sonerson developed previz action for the aircraft on location in Vancouver. Effects technicians then approximated aircraft moves on the gimbal set in real time, and Larry Fong designed lighting to simulate a battle raging below. “An army of knights is trying to bash its way into the castle while orcs are inside firing balls of fire,” said John DesJardin. “When Damon Caro’s young daughter was looking at our previz, she called those ‘exploseballs,’ and that is what they became.”

Animal Logic CG supervisor Emmanuel Blasset oversaw digital builds, including a model of the B-25 textured with retro nose cone decal of *Babydoll* astride a bomb, and a castle environment based on artwork by Aaron Sims and line drawings by Animal Logic conceptual artist Peter Commins. “We built prototype 3D sculpts of the set, and Peter drew over the top,” explained Animal Logic visual effects supervisor Andy Brown, who accompanied the shoot with Animal Logic CG supervisor Andrew Chapman. “The castle had a central chimney section carved out of strange, alien stone. But the main structure around that was gothic and medieval, with bits of crazy ‘orcitecture’ that the orcs had built.” The castle sat on a volcanic butte surrounded by a moat of molten lava, a stone bridge, flat lava plateaus and distant volcanic mountains. Animal Logic modeled the environment in 3D, with matte-painted projections based on photographic reference of Icelandic landscapes.



*Babydoll's third fantasy transports her and her team onto a Mitchell B-25 bomber, jerry-rigged with one propeller and one jet engine, soaring above a medieval castle. Animal Logic generated a highly-detailed digital replica of the B-25 based on full-scale portions of the aircraft that the production constructed on a gimbal motion base. The castle setting included a central chimney surrounded by gothic structures perched on a volcanic butte. Hordes of orcs inside the castle, and medieval knights storming from without, were created in wide shots via digital crowd simulations.*

Practical castle sets included a 30-foot-square courtyard and entrance to the chimney, and separate set pieces backed by greenscreen for the main gate and castle ramparts. The art department also built a partial prop catapult and large urns used for pouring burning oil down castle walls. Snyder filmed action in greenscreen vignettes, with knights and orcs performing stunts, including launching practical exploseballs—clay balls coated in tar-like flammable liquid—made by Joel Whist’s team.

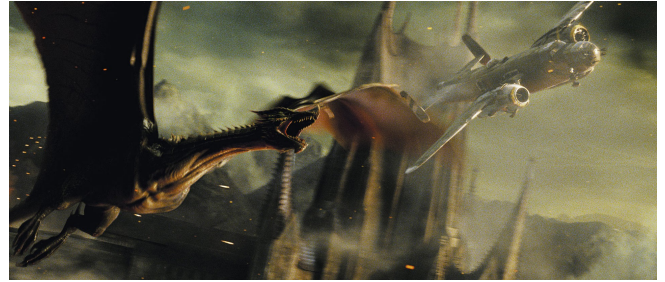
Animal Logic composited elements into the digital environment and, for wide shots of swarming crowds, conducted a day of motion capture sessions at Giant Studios. “Motion capture was the quickest way to grab crowd actions,” stated Andy Brown. “We had a lot of greenscreen reference to match to, so we didn’t need to build full artificial intelligence simulations. We used Massive crowd simulation software and sampled vignettes from various fight scenes and people running around, then built those into loops and alternated between cycles.”

The B-25 scatters orcs by swooping low over the castle and dropping a propane bomb into the courtyard. Production filmed the aircraft approach with the camera swinging past Amber in the cockpit set, manually rocked on pneumatic tires. Animal Logic transitioned to its CG plane performing a banking move designed as homage to a Millennium Falcon maneuver from *The Empire Strikes Back*. The shot then transitioned back to the fuselage set as Wiseman drops the bomb. “It was tricky to massage timings of the practical elements and the drift of the plane,” noted Brown. “We designed that all in previz, but the moves were shot wild. Layout lead Andrew Ritchie set up a transition between the two cameras in Maya, and animated the digital B-25 banking away to avoid an explodeball. We then used The Foundry Nuke to pre-comp the shots; and our compositing lead, Dave Dally, and compositor Xavier Bourque incorporated all the matte paintings and greenscreen elements.”

Joel Whist’s team built Wiseman’s bomb as a lightweight fiberglass propane tank with a flare attached that Scott Glenn could ignite and drop from the gimbal set. Whist then used a mixture of propane and propylene to create a fireball impact that spread to a diameter of approximately 20 feet. Animal Logic added dust and a shockwave that filled the CG castle set and obliterated orcs.

Babydoll, Amber, Sweetpea and Sweetpea’s sister Rocket (Jena Malone) leap down into the courtyard, cratering its surface. The actresses performed the leap on wires against greenscreen, then Animal Logic re-timed their descent with split-screens, and animated stone tiles cracking and shockwaves of debris. The girls then blast their way into the castle’s central chimney using explosives. “We used a string of det’ cord, which is standard issue for Special Forces,” said Joel Whist. “It was rolled PETN in the form of a sticky tape containing a blasting cap. You roll it down, stand back ten feet, hit a detonator, and it blows a shaped charge to break the seal on a door. Zack gave his approval, Damon’s military consultants supervised the girls, and they did it for real.”

Inside the cylindrical brick chamber, Babydoll leads her companions onto a platform overlooking a dragon’s nest above a volcanic chasm. Production filmed the scene on a floor-level platform dressed



*The B-25 evades a fire-breathing dragon that emerges from the castle to give chase to its attackers. Animal Logic generated the beast based on the production’s conceptual designs and 3D models, which they adapted into a keyframe-animated creature with bat-like wing membranes spanning more than 260 feet. The production refined the dragon’s flight using 3D animatics which, during principal photography, guided motion of the B-25 gimbal set. Animal Logic then matchmoved plates and created transitions from the practical set to the CG aircraft in dynamic shots that moved in and out of the bomber.*



*The dragon overtakes the B-25, chomping at the rear gun turret from which Amber is firing. For interior views of the bomber’s tail assembly being torn away, the production built before-and-after versions of the damaged fuselage, which Joel Whist’s special effects team rigged with sparking pyrotechnics and blasted with wind machines to send debris flying. For views of the dragon’s mouth opening wide and almost swallowing the camera, Animal Logic detailed its digital creature with glistening translucent flesh and flying spittle, and added dynamic crunching sections of fuselage, sparks and debris.*



with prop bones. Quantum Creation supplied an articulated green latex form to represent a sleeping baby dragon, which *Babydoll* slaughters. For a closeup of *Babydoll* slicing the baby dragon's neck, Quantum makeup effects artists created a silicone prosthetic with greenscreen skin and realistic internal organs. *Babydoll* extracts a pair of crystals that, clashed together, produce an unearthly glow resembling the aurora borealis. Animal Logic effects lead Jeffrey Kember's team generated the effect using Houdini fluid particle and fire simulations.

A sheet of flame rises from the chasm, out of which the furious mother dragon appears. Joel Whist created billowing flame effects as practical pyrotechnic elements, staged at 1/6-scale and filmed at 150 frames per second. "We built a proxy of the bridge and let off propane explosions below that," said Whist. "We used a mix of propane and Mapp gas and shot various sizes and speeds for DJ to mix together. We also used two flame-throwers to shoot elements for the dragon shooting fire at the girls." Animal Logic added the surrounding CG chimney, rocky pit and volcanic pool with interactive lighting, blending pyrotechnics with digital fire created in the studio's fluid simulation tool, Snap.

Aaron Sims designed the dragon and its baby as tri-horn bipedal reptiles. Animal Logic adapted Sims' Pixologic ZBrush models as keyframe-animated creatures. Character supervisor Raffaele Fragapane and animation supervisor Kenn McDonald rigged and animated the dragon for a wild chase sequence in which the creature emerges from the castle and chases after the B-25. "The dragon was keyframed apart from some simulations in its wing membranes," said Andy Brown. "We designed those to resemble the wings of a bat, but the wingspan was about the size of an A380 Airbus, and it had to do some crazy moves, chasing the plane through dives and stunts that a B-25 probably couldn't do—particularly with one jet engine attached."

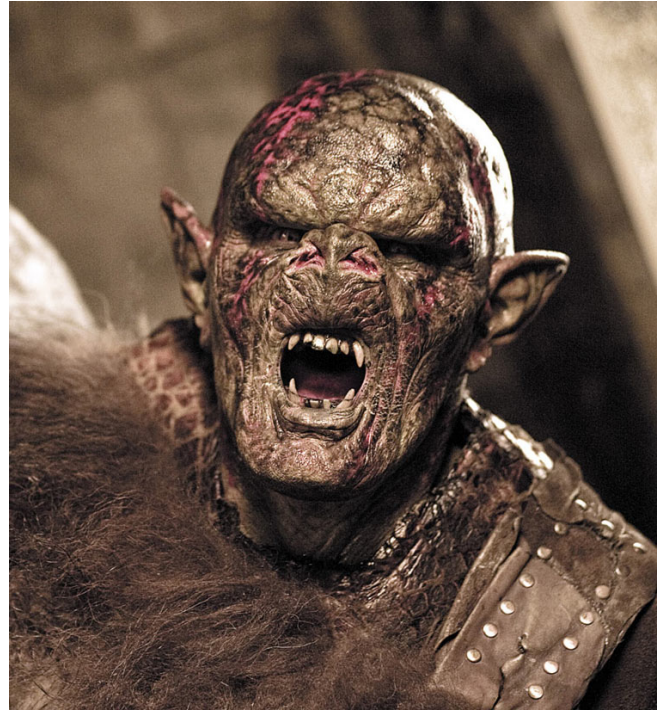
Amber opens fires on the dragon, which chomps on the B-25's tail assembly. The production rigged the gimbal set with before-and-after versions of the severed tail, and Joel Whist's team supplied pyrotechnic sparks and gusting wind effects. Animal Logic digital surfacing lead Jean-Pascal LeBlanc then dressed the dragon's mouth with fleshy details and spittle as the giant creature ripped at the aircraft.

The crippled B-25 takes evasive action by banking sharply and swooping between the arches of the stone bridge at the castle gates, followed by the dragon which crashes into the structure. Animal Logic simulated toppling pillars of stone that interacted with the keyframe-animated dragon, and generated knights as Massive agents that blended into rag-doll simulations blasted on wild trajectories.

When the dragon attacks *Babydoll* in the castle courtyard, she leaps onto the creature's neck to deliver a killing blow. Animal Logic keyframe-animated the dragon crashing into the ground, and simulated dynamic interactions of the creature plowing through masonry and churning earth. *Babydoll* was rendered as a fully digital character, a combination of MPC's asset and Animal Logic's custom hair simulations. Emily Browning performed the landing astride a greenscreen form representing the dragon's neck. For the moment of the kill, *Babydoll*'s sword swings through frame, revealing surface detail on the blade. "Alex Pardee created a wonderful series of images that represented the iconography of *Babydoll*'s fantasies," said Rick Carter. "It was a concoction of elements from her dreamscapes, all mixed up in time and space in a very fluid way, engraved across the weapon."

Animal Logic created the digital version of the sword from high-resolution scans of the hero prop, and from scans of the intaglio design, and then projected the 8K texture onto the sword's geometry. As the dragon slumps, the camera pushes in to a closeup of *Babydoll* and moves around her head to reveal her in the dance hall at the completion of her stage act. Snyder filmed repeat passes of Emily Browning, first against greenscreen and then in the theater set. "It took a while to digitally reposition and stabilize the plates," remarked Andy Brown. "Emily was wearing a headset in the dragon fantasy, and they wanted to keep that through the move, so we married that part of the plate to Emily's head in the second plate. As the camera came around, the headset went behind her pigtail; and then, by the end of the shot, as the camera swung around, it had disappeared."

The fourth and final fantasy begins when *Babydoll* and her accomplices attempt to steal a kitchen knife. The camera spins around the kitchen and comes to rest in a futuristic alien world, where Wiseman waits with a Huey helicopter on a helipad. Prime Focus created the transition between Browning in the kitchen set and a greenscreen helipad platform, which production had built, along with a full-scale portion of the Huey. Prime Focus completed the helicopter body, and, for the surrounding environment, enlisted the assistance of digital terrain specialist Matthew Fairclough, proprietor and lead developer of Planetside Software Terragen. "We wanted the flexibility of Terragen's 3D capabilities," noted Bryan Hirota. "We used that to create atmospheric falloff and light scattering through the clouds, casting moody shadows on the environment." Prime Focus visual effects art director Kenneth Nakada designed the terrain. "We built a rocky area where the helicopter platform lives, which we called 'Utah.' And then we had a vast, open wasteland with spiky formations, very much like H.R. Giger's planet in *Alien*." Digital effects supervisor Chad Wiebe oversaw creation of a library of terrain elements that could be applied in a



*A race of fierce orcs protects the castle, living in symbiosis with the dragon and her offspring, which inhabit a subterranean chamber. Quantum Creation created more than 100 orc makeups using about a half-dozen sculptures and a variety of paint schemes applied to 30 stunt performers at a time.*



*Special makeup artist Kevin Kirkpatrick applies foam latex appliances to makeup effects project producer and Quantum Creation co-founder Christian Beckman, who during preproduction submitted to a full orc makeup for a film test of the creatures' aesthetic movement and skin tones.*



procedural fashion. Lighting and rendering supervisor Andrew Roberts and compositing supervisor Patrick Kavanaugh layered volumetric dust and debris between the peaks.

For shots of the helicopter in flight, Snyder dispensed with a motion base, and relied on Technocrane camera movement and practical wind effects to simulate airborne motion in a greenscreen set. Prime Focus added planet terrain with reflections in the cockpit canopy and stroboscopic effects of rotors flickering overhead.

The Huey bears down on a magnetic levitation train that skims across the planet carrying a ‘razor bomb’ that *Babydoll* must disarm. Prime Focus modeled the maglev train—a hulking grime-streaked locomotive with an enigmatic cowcatcher—from Aaron Sims conceptual designs. Modelers constructed the rail system in modular sections interspersed with giant jet engines that held the track aloft. “It was the most wasteful form of transportation you could invent!” observed Hirota. “To show the train’s mass, we added procedural motion to the tracks, and as the train went over the supporting jets, we made them power up and dial back down.” To generate alien planet scenery streaming past, Prime Focus created terrain renders stitched together in a navigable loop. “We created a running spherical environment, and brought that into Eyeon Fusion, which gave us an accurate 3D view of the environment from anywhere inside the train. If that solution wasn’t suitable, we fired up a special render.”

Rocket launches a grenade to blow away the rear wall of the train car and she, *Babydoll* and Sweetpea board the train on jetpacks. Joel Whist’s team built a small-scale black proxy version of the back of the train, and then blew it apart with detonating cord. Prime Focus blended the high-speed explosion element into a digital simulation of the rear of the train exploding. The train’s interior was then rendered almost entirely digitally for a subsequent sequence where, in a single shot, *Babydoll* and company fight their way through a horde of armed robots guarding the razor bomb.



When the dragon crash-lands in the castle courtyard, *Babydoll* leaps onto its neck and delivers a lethal sword thrust to its skull. Animal Logic keyframe-animated the dragon and simulated dynamic interactions of the crash landing.



Emily Browning performed the landing on top of the dragon wearing a stunt harness on a greenscreen buck that the art department provided with a soft section for stabbing. Joel Whist’s team mounted the head on skis and rigged the jaws to close as the assembly pushed forward to its resting position.



Techviz animatics informed train set construction. “We did a couple of walk-throughs in mockups of the set,” recalled John DesJardin. “We talked about building half a car, or a version with no ceiling and part of a lower wall. I finally suggested it would be better without any walls. I knew there were going to be times when we’d play interactively with lenses to either compress or open up distances between characters and the environment for dramatic effect, and I figured without any practical set we could play with those distances. In the end, Rick Carter built only the floor, which was painted green and slotted with a light source. The slots helped us gauge where we were in the train; the rest was all greenscreen.”

To choreograph camera placement for the sinuous action sequence, Snyder shot stunt walk-through footage using his iPhone. The tiny camera-phone, clipped into a Zacuto ZGrip pistol mount, allowed ultra-close angles skimming performers while Snyder puppeteered a prop bullet on a stick to visualize shell casing trajectories. “We felt out each move until we learned the fight 100 percent,” remarked Zack Snyder. “By anticipating each move in the choreography, I knew where best to place the camera before we swung around to get the next kick or blow. If you don’t know your way around a fight, the camera will get lost.”

The filmmakers divided the action into 65 camera setups designed to flow together from one to the next, incorporating live-action, digital doubles and animated robots into a seemingly unbroken two-and-a-half-minute shot. “It took two and a half months to wrap my head around how we were going to break that sequence apart and piece it back together,” said John DesJardin. By methodically testing setups, snatching moments with performers and stunt artists on set, DesJardin corralled shot-building methodology into footage that George McCarthy assembled for techviz playback on set, clearly delineating parameters of the shoot.

The production shot train car action in two simultaneous units—Babydoll in one, Sweetpea and Rocket in the other—each interacting with six to eight green-suited robot performers. Both units shot high-speed, at 150 or 360 frames per second, requiring extremely bright light levels and great precision in fight choreography. “There were a few times when, for safety reasons, we performed the action 15 percent slower than real time,” said Damon Caro. “But the majority of the time, we had to go 100 percent to get the energy in there. If you shoot high-speed and you don’t attack with full energy, a stunt loses its intensity.”

Snyder and his team filmed the train fight in two and a half days. Prime Focus then assembled elements to bring the train interior to life. “We added shaking effects and lens flares,” noted Bryan Hirota. “The shake was partly because the set was not moving. But we also wanted to make it a



*Wiseman observes as a Bell Huey helicopter lifts off from a helipad in the fourth and final fantasy, in which Babydoll and her companions attempt to stop a bomb-laden monorail train from reaching a city on an alien planet. The production filmed helicopter scenes with a full-scale section of the helicopter and a portion of the helipad. Prime Focus completed the helicopter body and generated a full 3D model with CG characters for wideshots. Prime Focus also generated the surrounding environment as 3D digital terrain, which allowed effects artists to layer volumetric effects of dust and clouds in between rocky pinnacles.*

little stylized, with secondary double images slightly blended in. We figured out procedural ways to generate those effects, with lens flares glinting off bright objects creating inner-lens reflections.”

Robots appear as six-foot-four-inch shiny metal bipeds, with mirrored faceplates and handguns. To integrate characters into the largely virtual set, Yannix Technologies provided Prime Focus with matchmoves of performers, and generated initial proof-of-concept tests. Prime Focus then generated 3D robot models, based on Aaron Sims’ designs, and animation supervisor Lyndon Barrois manipulated performances rotoscoped from plates. For human digital doubles, Prime Focus used the *Babydoll* model built at MPC, Animal Logic’s Sweetpea and Blondie (Vanessa Hudgens) models, and built models of Rocket and Amber in Zbrush, using Autodesk 3ds Max and Cyber Radianc Hair Farm to create dynamic effects and styling.



*The helicopter pursues a futuristic monorail held aloft above the planet surface on rocket boosters. Prime Focus modeled the magnetic levitation train based on Aaron Sims designsthat depicted the locomotive as a hulking, grime-streaked engine equipped with a vicious-looking cowcatcher. Modelers built the rail system as repeatable structures that clipped together in modular sections. Effects artists then riggedthe rails to interact procedurally as the train passed by overhead, conveying a sense of the vehicle’s mass.*

Prime Focus generated its first rough pass of the sequence at full slow-motion speed, which had the two-and-a-half-minute shot decompressed into an 18-minute assembly. Hirota’s team divided action into five manageable subsections. Snyder and Bill Hoy then generated speed-ramps, providing new templates for animation timings. “We plugged the editorial data into a system that analyzed the footage,” related Hirota. “We then only rendered frames that were in the shot and figured out what we wanted to do with motion blur. We rendered vector passes so we could dial blur up or down. If we felt it was important to have full 3D blur in the shot, like for the motion of the train cars, we baked that into the render.”

Final robot animation required interpretation to fit action to the mechanical creatures’ taller frames. “We used all the stuntmen’s interactions with the girls,” said Hirota, “but when the background stunt guys in the plates were waiting for their turn—Bruce Lee style—they needed stuff to do, so we keyframed all of that. And we had to modify performances wherever *Babydoll* cut a robot in half. Lyndon Barrois and his team did a great job of translating all those greenscreen performances into one cohesive piece.” Once choreography was locked, Chad Wiebe’s effects team added dynamic flying debris. “We rendered 3D volumetric smoke to interact with falling chunks of metal, sparks and tracer fire. We used Thinking Particles and dynamic effects in 3dsMax to create those effects.”

Compositors worked closely with effects artists to create handoffs between live and animated elements. “The part where *Babydoll* slices the robot vertically in half involved three separate live-action pieces,” related Hirota. “When *Baby* starts the jump, she’s mostly real—her arm and sword are CG. When she’s descending, cutting through the robot, she’s CG. When she hit her three-point stance at the bottom of that fall, we used a little bit of live-action, but when the camera readjusts, she’s CG. When she gets up, she’s real again. And then when she comes forward and strikes, and the camera moves around her, she’s all CG again.”

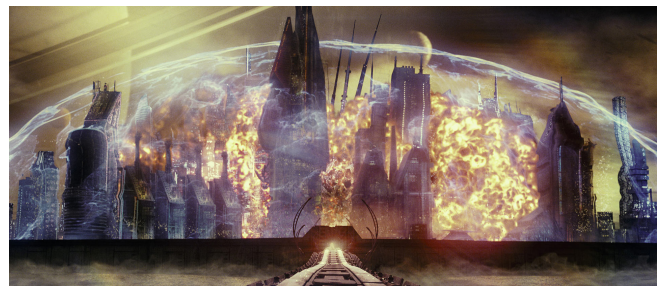
Prime Focus output the shot in 30 discreet renders, creating one seamless wave of destruction that culminated in a dramatic twist that leaves characters on a collision course with a futuristic metropolis—named ‘Bunny City’ after Babydoll’s pink bunny talisman. The art department designed Bunny City as a gleaming environment of steel and glass skyscrapers. “The city was Oz,” remarked Rick Carter. “It was an oil refinery meets Bethlehem Steel. And again we drew a parallel to Lennox House in its profile, seen front on.” Prime Focus created a layout of 3D buildings to define the central city area using an overlay of the Lennox House profile. Modelers generated smokestacks, pipes and industrial structures, and added peripheral buildings with more detail closer to camera.

Babydoll and Sweetpea escape the train, leaving Rocket to ride the bomb to its destruction in the city. The cataclysmic blast posed the challenge to Snyder and his visual effects team not to repeat themselves. “We wanted to make the city explosion look different to the one we had created at the end of *Watchmen*,” said John DesJardin. “We ended up creating a distortion field, which spreads out from the center of the event in a secondary wave, like a volcanic pyroclastic cloud over the city, full of lightning flashes along the roiling leading edge.” Prime Focus generated the explosion as an all-digital effect, wrapping smoke and pyrotechnic simulations around city structures, with a cyan-tinted dome of smoke full of Jacob’s-Ladder-style electrical effects.

Back in the brothel, the tragic outcome of the mission spurs *Babydoll* to alter her escape plan, sacrificing herself to save one of her friends. “Baby realizes she must convince the girls around her that they have the same power that she does,” stated Zack Snyder. “That’s what it takes her a whole movie to find out. Each one of them is as strong as they need to be, and they’re ready to fight.” Joel Whist’s team rigged a practical effect for a scene in which *Babydoll* causes a diversion that allows Sweetpea to escape, throwing a Molotov cocktail into a closet and triggering a fire alarm. Effects technicians rigged the closet set with a pyrotechnic charge, and treated the impact zone with flammables. Browning threw a breakaway rum bottle containing non-flammable liquid. As the breakaway hit the rear wall, technicians ignited the fuel.



*Babydoll leads a sortie into the train where she and two accomplices take on a horde of robots guarding the bomb. Zack Snyder staged the train assault in a lengthy shot that entered the rear of the train and followed the young women as they worked their way through two train cars, destroying robots. To create the impression of an unbroken camera move that navigated the fight, the production broke the action into 65 camera setups that dovetailed into one another, and then filmed actors in a greenscreen set with stunt players who provided motion reference for Prime Focus robot animation.*



*The train arrives at the alien city and the bomb detonates, sending out a blast that erupts in a corona of energy. The production designed the city as a metropolis of glass and steel – known as ‘Bunny City’ – the imagined home of an unseen race of alien creatures, and another nod to Babydoll’s lost innocence. Prime Focus constructed the environment as a conglomeration of 3D models configured in a manner that suggested the profile of Lennox House, and generated the shockwave as a gelatinous distortion field that expanded around buildings, with digital smoke and pyrotechnic simulations.*



Babydoll's sacrifice pays off in a scene set at a rural bus station, where Sweetpea infiltrates a group of passengers and makes her escape. The production filmed the bus station in a soundstage set backed by greenscreen. "I didn't want to go outside for a single shot," said Snyder. "I wanted the audience to accept that what they were seeing was reality, although it was insanely stylized. Shooting everything onstage was just another metaphor for that, showing how even what you perceive as reality is not real."

The concluding scene used a Supertechno 50 telescopic camera crane to follow Sweetpea as she boarded the bus. The rig then swung around the vehicle, which remained static in the stage. MPC generated bus station extensions, a CG bus and a stylized pastoral panorama. "We created a 360-degree environment with countryside and a town behind the bus station," said Guillaume Rocheron. "For the final crane shot going around the bus, we did a takeover to a CG bus, which then drove away into a very large wheat field with a gentle wind blowing across the fields. Zack referred us to the work of the painter Andrew Wyeth, and we emulated that in terms of light temperatures, creating a warm and colorful environment."

Babydoll's story—requiring a total of 1,032 visual effects shots—took the production on a genre-bending journey through a labyrinth of fantasy filmmaking styles. "It felt like we were wrangling five movies at once," remarked John DesJardin. "There was a different look to each fantasy, and that meant there were very few assets that we could amortize through the film. Variety can be fun, because on any given day you are playing with different colors and different kinds of action—but it can be dangerous because it's an open-ended sandbox. I have seen both sides of that coin. Greenscreen movies can bring savings—you are not bouncing all over the world, going to locations—but they can go crazy, too, costing hundreds of millions of dollars. We didn't have a hundred million! This was Zack's art movie. It was a small budget for the content, but what made this special is that Zack used his tools wisely. All departments worked together in a non-competitive way. We weren't pushing any particular style or technique, so the tail was not wagging the dog. That is what I'm proud of on this project."

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# THE GOOD THE BAD AND THE DUSTY

image

BY JODY DUNCAN

Shortly after the release of his first *Pirates of the Caribbean* film, director Gore Verbinski was enjoying breakfast at Art's Deli in Los Angeles with children's book illustrator David Shannon and writer/producer John Carls. The conversation moved to the topic of projects on which the three men might collaborate, sparking an intriguing suggestion by Shannon and Carls: "How about a western with creatures in the desert?" And with that, *Rango* was born.

A full-length animated feature, *Rango* tells the story of an unlikely hero's journey. A chameleon that has led a sheltered life inside a terrarium, *Rango* (Johnny Depp) faces a harsh world when he is inadvertently expelled from the family car during a move westward. Alone and frightened in a vast, hostile desert, *Rango* makes his way to the parched, drought-ridden town of Dirt—Population: Thirsty—where he passes himself off as a tough-as-nails lawman, and then grows into the role as he saves the local citizenry from all manner of black-hatted varmints.

*Rango* would represent a debut foray into full-length animated filmmaking for both Verbinski and Industrial Light & Magic, his visual effects collaborators on the *Pirates of the Caribbean* films. "Even though I'd never done an animated feature," noted Verbinski, "it was in my comfort zone because live-action visual effects directors work with animation all the time. We previz, we storyboard, we do layout. I've done *Pirates* movies that had 2,000 animated shots! So there was a comfort level there for me; and, of course, I had built great relationships with the people at ILM. We'd been to hell and back with the *Pirates* movies; and I knew I could trust them, even though they'd never made an animated movie before. We decided that lack of experience was an advantage, because that in itself was a guarantee that *Rango* would be singular. It could be singularly horrible or singularly brilliant, but we knew it would be singular."

Inspired by the breakfast conversation, Verbinski blocked out a storyline in a three-page outline, and then put it aside as he went on to make two more *Pirates* films over the next four years. "The idea sat dormant for those few years," Verbinski said, "but coming off the *Pirates* movies, I really wanted to do it. It seemed like the right time to slow things down, spend a bit more time at home, and 'work small' for a while. I knew that for the first year and a half or so, I would be working with a small group of people, doing character design and creating a story reel, and I liked that idea—assuming this was a story worth telling. So I began fleshing out the story with writers John Logan and Jim Byrkit, and what evolved was essentially an identity tale. The main character is a chameleon, and so the central question the story asks is: 'If you can be anything, who are you?' We thought that if we could splice that core idea into a classic western genre, we would have something special."

Initiating an 18-month design period, Verbinski assembled a team of eight artists that included Byrkit, Mark 'Crash' McCreery, David Shannon and Eugene Yelchin, all of whom worked with the director in a small house he had been using primarily as a music room. "At that point," Verbinski

recalled, “I had what had become a five-page outline, which had a beginning, a middle and an end. Specific scenes were defined, and there were bits of dialogue here and there. So it was only a sketch—but enough to say, ‘there is exile, there’s resurrection, there’s catharsis,’ along with the classical elements of the genre. Those pages laid out the basic narrative, and the design work expanded on that. The artwork informed the dialogue and the narrative, and the artists contributed crucial ideas. The idea of a mariachi Greek chorus, for example, came from a drawing *Crash* had done of four owls playing instruments. When I saw that, I said: ‘That will be a Greek chorus to help us tell the story.’”

McCreery would eventually earn a production designer credit on the film—his first such credit, and his first experience designing for an animated feature. “I was a little nervous in the beginning,” said McCreery, “because I wasn’t an animation guy. Early on, I tried to do some traditional animated-film-type caricature drawings, and I was stumbling. As we discussed the look of the movie, though, Gore kept referencing Sergio Leone and John Ford, two of my favorite directors, as well, and I quickly started to envision what this film could look like. I began to create drawings with deep focal depth, extreme foreground-background relationships and very contrasted lighting situations—a very Leone, very un-animated look. We all gravitated toward that aesthetic and started to approach it from a cinematic point of view, as opposed to an animation point of view. We attacked it from all sides as if it were a live-action film—and thank God we did, because I finally felt comfortable with what I was bringing to the project. The approach was right up my alley.”

Verbinski had been a fan of Sergio Leone’s westerns since childhood. “I remember sneaking into *Duck, You Sucker* when I was 11 years old and feeling like I was peeking into a forbidden world,” Verbinski recalled. “I became a John Ford fan later in life, but I originally entered the western through the post-modern western, stories set against the backdrop of the myths dying—the railroad is coming, and the West is changing due to progress, and what does a gunfighter do in this changing world? There was always, for me, a strange sadness about it, a sense of despair in characters who were a little out of their time, who knew that the future was coming and couldn’t stop it. That fascinated me.” It wasn’t just the Leone themes that appealed to Verbinski, however, but also the Leone cinematic style. “Leone’s compositions are a nice hybrid of the ‘B’ movie and high art, and we brought that same style to *Rango*. For example, animated movies normally don’t have extreme closeups—the characters aren’t designed for them, and there’s no reason to do them. But we wanted to have those types of compositions in *Rango*.”

‘Working small,’ just as he had envisioned, Verbinski and the concept artists designed hundreds of characters over the next 18 months, generating many iterations of each so that, by the end, the pieces of artwork numbered in the thousands. Among those pieces of art were many, many iterations of *Rango*, produced as the artists struggled to define, in visual terms, the movie’s central character.

Jim Byrkit and David Shannon both rendered early sketches of *Rango*, inspired by a trip to a pet store to



The debut full-length animated feature for director Gore Verbinski and the artists at Industrial Light & Magic – his *Pirates of the Caribbean* collaborators – *Rango* is the story of a pampered, terrarium-dwelling chameleon, Rango (Johnny Depp), who is thrown into a harsh and inhospitable desert when he is separated from his family during a move out west. Making his way to the parched,



study lizards and chameleons. “They noticed that there was an incredible amount of expression in a chameleon’s eyes,” noted Crash McCreery, “so they incorporated as many of those qualities into their initial sketches as they could.” *Rango* would still be a stylized chameleon, however—bipedal and wearing a garish Hawaiian shirt. “That was to reflect his original indigenous tropical habitat and to communicate the safe, easygoing life he’s had.” The character was also designed with decidedly asymmetrical features. “We took a risk by making *Rango* asymmetrical and not exactly attractive. We kept the tiny eyes of an actual chameleon; and that was a risk, as well, because small eyes are an animation no-no if you want to make a character appealing and likable.”

*drought-ridden town of Dirt, the timorous Rango assumes the role of a heroic lawman and leads a makeshift posse comprised of Dirt’s quirky townsfolk to track down a villainous gang.*

No character was more of a design struggle than was the lizard-like Beans (Isla Fisher), the spunky rancher’s daughter who becomes *Rango*’s love interest. Early on, David Shannon had done a simple sketch that captured Beans’ attitude and essence—but fleshing out that sketch in more detailed drawings proved problematic. In fact, Beans would be the single most difficult character at every stage of production—design, modeling, animation and rendering. “It may have been that she just wasn’t high-concept enough,” said Gore Verbinski. “High-concept characters are immediately there, and you can’t break them no matter how many ways you draw them. Beans was always a little mushy.”

“Beans was so difficult,” added Crash McCreery, “I still wasn’t sure she was going to work until I saw her fully lit and rendered in shots. The main problem was that she had to be attractive—but, believe me, it is very difficult to make a lizard look kissable.” To make Beans more appealing, McCreery rendered some drawings of her as a chipmunk, a creature whose soft fur and large eyes upped the ‘pretty’ factor considerably. But Verbinski vetoed the idea. “Gore had a problem with the lizard/mammal love connection, so we dropped that. Finally, we realized that we were trying too hard to make sense of everything, and that we’d be better off going with our guts. That’s how we wound up with Beans as a lizard with huge eyes, human-looking lips, a dress and Shirley Temple ringlets. Hair didn’t really make sense on a lizard, but we ignored convention and went with it anyway. I think she turned out fantastic.”

Quirky, nonsensical features would be evident in the final designs of many characters, whereas others—especially the villains—would adhere more closely to nature. A hawk that menaces *Rango* early in the film, for example, was designed to look like a real bird of prey; but even that realistic character featured an inexplicable metal piece on its beak, modeled after the tip of a cowboy boot. Rattlesnake Jake (Bill Nighy) was another relatively natural-looking character. “We did give Rattlesnake Jake eyelids,” said McCreery, “because we knew they would help with expression; but other than that, he was based on a real snake—and on Lee Van Cleef’s



Verbinski launched the nearly four-year-long *Rango* project by gathering a team of eight concept artists to develop characters and settings over a period of 18 months. Working out of a small house owned by the director, the artists produced thousands of pieces of artwork that aided Verbinski as he fleshed out his original

character from *For a Few Dollars More*. We often found iconic film characters to guide us in our designs. For example, I designed the mayor, who is this very old tortoise in a wheelchair, after John Huston in *Chinatown*.”

Though character designs consumed much of the artists’ time during the conceptual period, the film’s environments—the town of Dirt and its desert surroundings—also demanded an intense design effort. To soak up general atmosphere and capture reference photography, Verbinski and members of the design team spent a week camping in the Mexican desert, and also took day trips to explore desert locales not far from Los Angeles. It was during a visit to Joshua Tree National Park, 160 miles southeast of Los Angeles, that the artists stumbled upon the story’s ‘desert spirits.’ “We had been struggling with what those would be,” McCreery commented. “And then, as we were leaving Joshua Tree, we drove past this column of cacti called ‘Spanish Daggers.’ I said, ‘That looks like a face.’ And when we stopped the car, got out and studied them up close, we could see that they really did seem to have faces formed out of the leaves sprouting from their crowns—creepy, but with a certain nobility. And that was it. ‘We’ve found it! This is our desert spirit!’”

Most of the vegetation and plant life the artists saw on their desert excursions could not be used in *Rango*’s environments, however, since the plot revolved around a prolonged drought that has left the desert and the town parched and all but dead; and that air of desolation and despair would inform every detail of the environments’ designs. Another early concept for the town was that it would be made up entirely of discarded human trash that townsfolk had presumably found alongside the highway. “We created artwork of buildings that were made up entirely of tires and gas cans and that sort of thing,” said McCreery, “but we ran into scaling issues very quickly. Another problem was that it just didn’t fit our world, especially as the characters became more real. So we discarded the idea of making everything in the town out of trash. There are still a lot of found objects that make up the buildings, but that’s a tertiary read. You see the saloon and it looks cool, and it’s only after a second or third look that you realize there is part of a gas can there among the wood planks. We wanted it to read as a western town first, and then you’d notice the fun things and the pieces of trash when you looked more closely. ‘Oh, those are matchsticks that they’re using for railings!’” Ultimately, the concept artists designed 40-plus buildings for the town of Dirt, including a bank, jail, general store and ‘Power Tools and Proctologist’ building.

During the design phase, Gore Verbinski recognized that to bring cohesion to the character and set designs coming out of the different artists—each with his own aesthetic and style—all of those designs needed to be ‘processed’ through a single artist. That artist was Crash McCreery. “We called it ‘Crashifying,’” stated Verbinski. “We’d look at something, and say, ‘Okay, that’s great—now let’s Crashify it,’ which meant sending it through Crash’s brain, essentially. In the case of character designs,

story outline with writers John Logan and James Ward Byrkit. Verbinski reviews final character designs with ILM department heads. Visual effects supervisors John Knoll and Tim Alexander oversaw ILM’s work on the show, which demanded a streamlining of the company’s pipeline to enable the effects team to generate nearly 2,000 extremely detailed shots on a modest budget and within a fairly tight time frame.



Menaced by a hawk, Rango tries to blend into the harsh desert surroundings by emulating a cactus. Although Rango would be an essentially anthropomorphic character – bipedal and decked out in a Hawaiian shirt indicative of his cushy lifestyle – artists also incorporated real

for example, Eugene Yelchin came up with a great silhouette of Priscilla, the little orphan girl. Eugene's original artwork had the essence of that character, but it was still illustrative and raw. So we said, 'That's a winner, that's our girl—now let's *Crashify* it.'

*chameleon features into his design, such as scales and very small eyes, atypical of an animated hero character. Artists also flaunted convention by endowing Rango with decidedly asymmetrical features.*

Crash, who has no ego about this kind of thing, preserved the best parts of Eugene's drawing, but worked on the eyes, the skin texture, the hair—and suddenly the character came off the page. He did that to everything—wardrobe, buildings, shoes, ceiling fans and shafts of light coming through the window. We put all of that through the genius of Crash McCreery because we knew that what came out the other side would have his signature aesthetic, and everything would benefit from that."

As designs and story gelled, Verbinski and Jim Byrkit created a story reel of the entire film, working with rough pencil sketches and voicing the dialogue themselves. "We kept it all pretty loose and alive and breathing," recalled Verbinski. "We would do a couple of quick sketches, record the voices, put it together, look at it, go back, rewrite it...and eventually, it started to come alive. Previz is beautiful, but we found that at that stage, there was nothing more immediate than pencil and paper and a microphone."

About a year into the design period, ILM joined the *Rango* team, initiating a project that would consume many within the company for the next two-and-a-half years. Visual effects supervisors John Knoll—who had supervised the effects for all three of Verbinski's *Pirates* movies—and Tim Alexander would spearhead ILM's effort, along with animation director Hal Hickel. Already committed to other films, Knoll joined the production at the beginning, and then re-turned toward the end to oversee a second unit that produced about 600 shots. Alexander supervised initial asset development and oversaw about 1,000 shots.

The first hurdle that ILM would have to clear, as Verbinski saw it, was moving its focus from 'the shot' to 'the scene.' "I had to remind them, 'Hey guys, you're not making visual effects shots in a movie, you're making a movie,'" stated Verbinski. "That was a first for them, and it was a different way of working and looking at things. For one thing, everything had a context. Where is the character coming from? Where's he going? What is the emotional context we're bridging in this scene? So, at first, I was looking at stunned faces because they were delving into the unknown. But, eventually, I witnessed the birth of a really elite team of storytellers. We took a team of people who were very good at making shots and made them partners in a very different process—the process of telling a story from beginning to end."

In addition to making the mental shift, the team at ILM quickly realized that it would have to work differently than it did on a live-action visual effects film. Rather than generating shots—and deliberating over every detail of those shots—on *Rango* ILM would be creating everything, and for a relatively modest budget. To meet that challenge, the ILM leadership realized that it would have to streamline the company's pipeline, something John Knoll had been advocating since he had supervised the last three installments of *Star Wars*. "We launched a major effort to rethink every step in the pipeline," said Knoll. "We reexamined every phase of production to see if there was a smarter way of working. Is there a tool we could put in place to make that go faster? Is there a



different way of doing this that can improve that? We tried to wring out the entire pipeline for maximum efficiency, and that allowed us to achieve the quality and detail level that Gore wanted for *Rango* on a much lower budget.”

One example of streamlining involved scene management. For some years, ILM’s technical directors had lamented the fact that when a shot was turned over to them, they spent a good part of the first day, or more, just importing files, attaching lights to passes, and doing other prep work. “That meant that for the first day or so they weren’t making creative choices about color and placement of lights and all those aesthetic things that I wanted them to be doing from the very beginning,” said Knoll. “So we asked ourselves if it would make more sense to have a technical assistant do that kind of work, or maybe graft it onto the end of the layout phase. We implemented a preflight phase on all the scenes to get everything imported and hooked up by a small group of people who became very efficient at it. And then they would hand over a working shot file to the TD, who could be productive immediately.”

ILM also adjusted its pipeline to facilitate the transfer of lighting setups from shot to shot, a situation that was going to apply to the sequence-oriented animated film far more frequently than it did in ILM’s usual visual effects work, in which TDs were matching to the ever-changing lighting in live-action plates. “In the past,” explained Knoll, “even if we did have like lighting between two shots, it was still a laborious, manual process to transfer the lighting from one shot to the next. We had to go into the shot file, pull the things that we wanted, copy them, and then edit them into the scene file of the other shot. On this, we wanted to put a lighting rig in a master scene, and have all the other shots in the sequence inherit that lighting. If we wanted to make a change in the lighting, we could just change it in the master scene and it would propagate to all the other views in that direction.”



*Rango* marked the first production designer credit for Mark ‘Crash’ McCreery, one of the original concept artists on the show. In a process Verbinski dubbed ‘Crashifying,’ McCreery fleshed out sketches produced by the other artists to ensure a consistent, singular aesthetic in every aspect of the film. McCreery served the same purpose as ILM began shot production, making frequent trips to the San Francisco-based company to offer his input as 2D concepts evolved into 3D characters and sets. McCreery confers with Tim Alexander on the ILM motion capture stage, where the filmmakers conducted virtual location scouts of CG environments.

Concurrent with ILM's efforts to streamline the pipeline, its modeling crew began building the show's many assets, starting with the hero characters. "It was apparent immediately that we had a lot of work to do," said Tim Alexander. "We had to build about 80 unique characters, as well as another 50 background characters for crowd scenes, for a total of 130 characters. In addition to modeling all 130 characters, we had to rig them all, and many of them had to have their own unique rigs, just because the proportions and physiologies of these characters were so different." Technical creature supervisor James Tooley oversaw development of all the character rigging and controls, as well as cloth and hair simulations.

At the outset, ILM and Gore Verbinski had planned to divide characters into hero, secondary and tertiary categories, the idea being that midground and background characters could be less detailed than the hero ones, saving time and money. Hero characters would include *Rango*, Beans, the dozen members of *Rango's* posse, Rattlesnake Jake, and prominently featured townspeople, such as the mayor (Ned Beatty)—all of which would have to hold up in closeups. As shots evolved, however, even supposedly 'secondary' characters wound up in closeup, and required the same level of detail as did the hero characters.

Not surprisingly, the model crew tackled *Rango* first, with modeler Frank Gravatt working from the 2D concept art. "We picked a few of Gore's favorite illustrations of *Rango*," said John Knoll, "and started sculpting him from those. But one of the things we learned in that process was that a lot of the drawings conflicted with one another, and there were ambiguities between the front views and the side views. There would be a side view drawing that Gore liked a lot, but it would be a bit incompatible with the front view. 'Okay, he's drawn the eye ridges taller here, so they're the highest thing in the front view; but then in the side view they're lower.' We had to resolve all those ambiguities in our 3D model, and that meant doing many versions before we got it right."

Recognizing that an intermediate stage between flat artwork and full-rez 3D geometry was required—and again, with an eye toward streamlining wherever possible—the ILM team decided to sculpt all of the remaining hero characters as quick-and-dirty prototypes first, so that all of the design issues could be resolved before they moved on to the more time- and labor-intensive modeling. Once getting approved artwork, modelers would rough out a character in ZBrush, over the course of three days. Only after Verbinski and McCreery had bought off on the proportions of the ZBrush sculpt would the modelers begin building the actual asset, working in Maya and Zeno.



*By far the most difficult character to conceptualize was Beans (Isla Fisher) the spunky, lizird-like rancher's daughter. The design challenge arose from the fact that, as Rango's love interest, Beans had to be a somewhat attractive lizird. Early on, McCreery attempted to make Beans more visually appealing by rendering her as a pretty chipmunk with soft fur and a bushy tail – but Verbinski preferred a lizird-to-lizird love connection. The artists finally solved the Beans dilemma by embracing a more whimsical approach to the character, foregoing naturalistic lizird features in favor of ringlets, large eyes and human lips.*

As another resource-saving measure, the modelers attempted to keep the geometry as light as possible. “John Knoll impressed upon us at the beginning that we had to go lighter with our models,” recalled model supervisor Geoff Campbell, “just because we had so many characters. So we tried to lighten the geometry and do more in the paint, which worked well for the background characters. But in our principal characters, we ended up with the same amount of topology that we would have done normally, especially in the heads, because we had to have enough geometry there to get good facial performances.”



*The initial 18-month design period was a symbiotic one in which the story’s evolving narrative inspired concept designs, while evolving concepts inspired narrative and dialogue. A Crash McCreery drawing of owls playing instruments – apropos of nothing in the story – caught Verbinski’s imagination and led to the inclusion in the film of a mariachi band ‘Greek chorus’ that would break the fourth wall and narrate the tale.*

When the model was completed, the modelers went back into ZBrush to do displacement for textures, such as the scales that covered *Rango* from head to toe. “We would have a modeler create that as relief in ZBrush,” explained Campbell, “and then write that out as displacement and give it to whoever was painting the model—in the case of *Rango*, Steve Walton, who was the paint supervisor. Frank Gravatt did the ZBrush scales, and then Steve used that ZBrush relief as a guide in painting his textures, knowing where each scale was defined by the model.” Lead modeler Jung-Seung Hong, who had been the facial expert for Davy Jones on the second *Pirates* movie, created *Rango*’s facial library using ILM’s Fez facial modeler.

Geoff Campbell did the initial modeling and building of the facial library for Beans, and then handed it over to Gio Nakpil who created a wide range of facial expressions. It was only when the character reached this 3D modeling phase that design issues that had plagued the concept artists from the beginning were resolved. “The problem,” explained Campbell, “was that she didn’t look cute enough in the artwork. She looked kind of sullen, in fact, and she had a little bit of ugly going on. She didn’t have to be really beautiful, but she had to have some appealing qualities because she was the love interest. So we got away from that artwork right away, and because production was so busy with all of the other characters, they kind of threw it to us to help design the character.”

Among the changes ILM made to Beans was to shorten her a bit so she would not stand too high above *Rango*. There were also problems with head proportions in relation to *Rango*. “When they were next to each other,” Campbell remarked, “*Rango*’s head appeared to be four times as big as hers. The proportions were just way off, and we realized that we had to make their proportions a bit more similar. We had problems with her chin and lips, too, trying to figure out how far to go with those features to make her more attractive. The lips wound up much more human than any other character’s—but, again, this was *Dirt*, so it didn’t really matter. We had trouble with her lizard skin, because if it wasn’t just right, the textures would look like liver spots. We just kept going through iteration after iteration, and I was getting worried because we were about to go into production—and Beans wasn’t getting any more attractive. It took a long, long time, but we finally got it.” Martin Murphy painted Beans, and Damian Steel did the look development.



To gather reference for the far more realistic Rattlesnake Jake model, Campbell and members of his crew visited the Academy of Sciences in San Francisco, where they studied rattlesnakes and handled less poisonous serpents. Replicating the reptilian scales on those real snakes required collaboration between Rattlesnake Jake modeler Patrick Gagne, riggers and sim artists. “The scales on Rattlesnake Jake were really tricky,” commented John Knoll. “We see him close enough that we couldn’t really do the scales as just a displacement map on the surface. We needed to see that they were separate bits of geometry, like shingles on a house. Scales always present a problem, anyway, because there is no good way to prevent them from penetrating one another without doing a simulation.”

Kris Costa modeled the elderly, wheelchair-bound mayor, as well as the ‘Spirit of the West,’ a surprise character—a caricature of Clint Eastwood as he appeared in *The Good, the Bad and the Ugly*—that appears to a despondent Rango when he is doing some soul searching in the desert. ILM art director Aaron McBride developed the look of the character in a series of concept drawings, which Costa referenced as he sculpted the model and created the facial library.

Joining the hero characters in Dirt are dozens of quirky townsfolk. Due to the large number of these secondary characters, ILM had to devise shortcuts and other strategies that would enable teams to produce as many as possible, as quickly as possible. “We shared topologies and clothes,” said Geoff Campbell. “We built up a database that we call Top Hat, and filled it with hundreds of assets—pants, shirts, vests, gun belts, guns, all kinds of things. This library of wardrobe and props became very important to us in creating background characters.”

Sunny Wei modeled the ferret-like Lucky, who appears to be anything but, as he is covered with cuts, scrapes and bruises, has one foot in a cast and one eye covered in gauze. “Lucky is a good example of the level of detail that we had even in secondary characters,” noted Campbell. “His gauze patch had a yellow stain, as if he badly needed that dressing to be changed. All of these characters are kind of broken and worn out and vulnerable; and so we had a lot of details like armpit stains and threadbare clothing. All of that made these characters different from what you’ve seen before, and we were all thrilled to be working on something that allowed us to get down to that level of detail.”



After being lost in the desert, Rango attempts to acclimate himself to the dilapidated town of Dirt. An early concept for the town was that it would be made up entirely of trash that townsfolk had found alongside the highway, but artwork exploring the idea quickly exposed inherent scale issues. Another problem was that a town comprised entirely of paper cups, tires, gas cans and the like did not fit within Rango’s exquisitely photorealistic world. Rather than scrap the notion entirely, designers included bits of trash amidst the structures’ traditional wooden planks.

That same attention to detail would be evident in *Rango*'s environments. Much as the filmmakers had started out hoping to get by with less-detailed secondary characters, they had considered making environment backgrounds rather vague and abstract—again as a cost- and time-saving measure. “When we were trying to hammer the numbers down,” said John Knoll, “there was a lot of talk—and I think ultimately it was a lot of wishful thinking—about putting most of the detail into the characters, and less of it into the environments. The idea was that the characters would be high detail, and the immediate surroundings would be detailed so that the character looked like it belonged in that environment; but further out from that, we wouldn’t have to be so detailed and realistic. But as soon as we started putting the shots together, it looked wrong when the backgrounds didn’t have the same level of detail as the foregrounds and the characters. It just didn’t feel stylistically consistent.”

Model supervisor Russell Paul oversaw the modeling of Dirt. The art department provided ILM with a map of Dirt’s main street, with the placement of specific buildings clearly marked. The modelers found additional guidance in photographs of ghost towns such as Bodie, California, an abandoned—but largely intact—mining town in the Sierra Nevadas. “We were looking to add a bit more realism to the town,” said Russell Paul, “while keeping the character of the original sketches. It was clear in the drawings that these buildings were old and not built very well, and also partly made up of highway refuse. So, in addition to modeling cut wood and planks, we had to model pieces of trash and cans and that kind of thing.”

The modelers first made low-rez versions of all the buildings, complete with textures, which the layout team then placed to determine the town’s general orientation. “Once we had the town layout and the buildings in place,” said Paul, “we selected which buildings were going to be hero, and built those high-rez with a lot of detail. Some of the more distant buildings we left as basic geometry. We had a library of parts—pieces of wood that had cuts and knots broken out of them, windows of different shapes. Toward the end of the show, we were able to assemble buildings fairly quickly because we already had all of these assets in our library.” The team also built a high-rez street down the center of the town. “We laid that in, and I did a pretty complex sculpt to get the ground to swell up to all the buildings nicely and get them settled into the ground so they weren’t just sitting on a simple, flat plane.”



*Rango enters Dirt’s saloon, an intricate interior featuring weathered wood walls, walkways, hundreds of pieces of set dressing and many layers of texture to impart an aged look. The daytime shot of Rango first entering the saloon was among the most complex in terms of lighting, with sunbeams breaking into the seedy gloom, illuminating particulate matter in the air. To ensure a cinematic lighting style throughout the film, live-action director of photography Roger Deakins – brought on as a consultant – pulled shots with appropriate lighting scenarios from a variety of movies, providing ILM with essential lighting reference.*

After town buildings had been laid into a scene, a set dressing team would add hundreds of props to fill out the town. A tool called *Metropolis*, developed by Carlos Munoz, facilitated efficient set dressing, as it managed a large library of assets built for that purpose—clumps of grass, boulders, pebbles, dirt mounds, twigs, dead plants, water troughs, stakes in front of buildings where the Dirt version of horses would be tied, and all manner of western town paraphernalia.

Once in production, members of the digimatte group—now pulled into the regular ILM pipeline—would generate the town exteriors, with set dressing, and deliver them to the TDs so they would have the appropriate background for their shot. “The town was very modular,” noted digital production supervisor Mike Bauer, “so we could move the saloon next to the jail, for example. That helped layout quite a bit. The town was very complicated, and it took a lot of people to put it together, because it had to move from person to person, and each one had to be able to pull it apart and put it back together any way he wanted. It was a concerted effort between Russell Paul, Polly Ing—who put it all together—and the effects department, which added smoke coming out of the chimneys and all the atmospheric dust.”

The saloon, assembled from a fraying wicker basket and a rusty gas can, had one of the most complex interior environments, which included intricate wood sculpting in the walls and hundreds of pieces of set dressing. “The saloon interior had a lot of texture to build up a very aged look,” explained Russell Paul. “There would be something on a wall, for example, and it would be aged and peeled off, and something else would be behind it. It had to look as if the wood, the nails, everything had a sense of history, and we put in layers and layers of detail to give it that feeling.”

ILM continued to build assets throughout a year of preproduction, and even as formal production began in 2009. As always on an animated film, the vocal actors would be recorded performing the dialogue first, and those vocal tracks would guide the animators at ILM as they created the character performances. Gore Verbinski broke from tradition, however, in the way he recorded the vocal performances. Rather than record actors separately, standing alone at a microphone in a sound booth, Verbinski gathered his actors on a stage at Universal Studios, and had them rehearse and then perform the scenes much like a stage play as he recorded the dialogue ‘live.’ “I knew going in that one of the difficulties of animation is that you get nothing for free,” said Verbinski, “no surprising moments or happy accidents or unplanned moments of truth between actors. By throwing the actors all together in a room, I was creating an environment where they could act and react off one another, where we might get moments of truth that could then be translated to the animation. We encouraged the actors to stay loose and move around as they performed the scenes, and we recorded the dialogue with the boom right there in their faces. The soundtrack was of primary importance. It was our ‘exposed negative.’ The boom man was happy because he never had



*An extreme closeup of the aptly named Bad Bill (Ray Winstone) – Gila monster leader of an outlaw gang – was just one of hundreds of shots illustrating the overtly cinematic style and sensibility that would distinguish Rango from previous animated features. Though the filmmakers would reference the classic westerns of John Ford and others as they designed shots, they especially sought to emulate the lighting and camera compositions of Sergio Leone’s spaghetti westerns, of which Gore Verbinski had been a lifelong devotee.*



to worry about backing out of the scene.” To help the actors get into their roles on the stage, production provided minimal costumes and props.

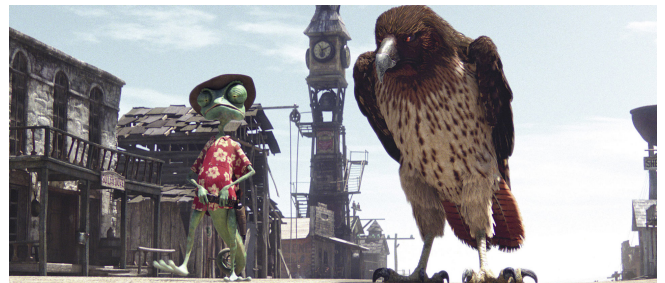
In addition to recording the sound, Verbinski shot all of the voice sessions with an HD camera. “We not only got this looser, more spontaneous sound out of the fact that the actors were there, interacting with one another,” said Hal Hickel who, as animation director, was on stage throughout the two-week shoot to pick up performance clues, “we also got tons of footage of what the actors were doing, which we could reference for animation. None of it was a blueprint for the animation, but it was an awesome resource to mine for hand gestures or funny expressions or weird little takes. For example, Stephen Root, who does several voices in the film, including Doc, the town drunk, was hilarious, so he was a terrific actor to steal stuff from for the animation. There was, happily, a fair amount of inspiration that sprang out of those live performances, and I was very glad to be there and soak it all up.”

Over a period of about a year, Hickel and a team of 55 animators—45 in *San Francisco* and another 10 at ILM’s Singapore branch—would animate more than 100 characters, 16 of which were hero characters with significant screen time. The HD reference from the stage, the recorded vocal performances, and the story reel were all building blocks of the final animation—but Gore Verbinski encouraged the animators to give their imaginations free rein. “Rather than tell them exactly what to do,” said Verbinski, “I just gave the animators a general vibe for a scene—and then I let them explore and see what they could come up with. I have an extreme fear of things getting too clinical, as the cerebral cortex takes over from ‘gut’ instinct. So it was important to give the animators some measure of freedom and spontaneity. What we all wanted to do was accumulate little moments—the awkward take, an interaction between characters that was a little off, an unexpected action. That was a core principle.”

Another guiding principle was that the animation for nearly all of the characters would be essentially anthropomorphic, regardless of their animal-world origins. “I remember John Knoll asking Gore early on if the characters should display animal characteristics,” recalled Hal Hickel,



Bad Bill and his henchmen confront Rango on Dirt’s main street. To create the town, ILM modelers first made low-rez versions of all the buildings, complete with textures, then built the hero structures for each scene at high resolution from general construction assets that included planks of wood and windows of various sizes. After buildings had been laid into a scene, artists added hundreds of pieces of set dressing using a new proprietary tool called Metropolis, which managed a large library of props and assets such as clumps of grass, boulders, dirt mounds, twigs, dead plants, water troughs, stakes and all manner of western town paraphernalia.



Bill’s gang wisely retreats when a hawk appears behind Rango. The designers and ILM realized the hawk and all the film’s villains as less stylized, more naturalistic characters as a means of maintaining their sense of menace – but even the photorealistic hawk sported an inexplicable metal piece on its beak, modeled after the tip of a cowboy boot. ILM simulated textured meshes to create the look of separate feathers on all the bird characters in the film.

“but that wasn’t the movie we were making. All the characters were sort of human characters that just happened to have animal features. Doc’s a rabbit, for example, and his function in the film is that he’s the drunk at the bar. That he’s a rabbit is sort of a secondary aspect of the character. You never see him hopping or eating a carrot or wiggling his whiskers in a rabbit way. Same thing with *Rango*. He had reasonably human proportions except for big feet and long toes and a tail, and we pretty much animated him as a human character. You do see him use his tongue to eat a bug at one point—but that’s about as lizard-like as he ever gets.”

The non-human physiologies of the characters did present some lip-sync challenges, however. “Gore didn’t want stylized or loose lip sync,” Hickel noted. “He wanted really tight lip sync, even though the characters were stylized. So, in addition to the performance reference, we were given video that corresponded exactly to the audio that had been selected for our given shot. That video might not be good performance reference, but it was the video that corresponded to the audio selected for the shot; and so, we could check our lip sync against it and make sure it was spot on. It is very easy to get sloppy with that stuff, especially when you are dealing with these weird kinds of anatomies.”

Rango’s exceptionally wide mouth and the inherent difficulties of animating that mouth in a realistic manner led to the development of a tool dubbed Sticky Lip Enveloping. “When *Rango* and other characters opened their mouths,” Hickel explained, “we wanted the lips to stick together and peel apart from front to back, just as a real person’s lips do. There was some technical wizardry required to do that. Sticky Lip Enveloping allowed us to basically zipper lips closed from the corners up to the front of the mouth, or the other way around. That gave the characters’ lips a very natural, fleshy feel.”

Associate animation supervisor Kevin Martel also served as *Rango* animation lead. For reference, Martel and the animators looked at Don Knotts’ characters in comedic westerns such as *The Shakiest Gun in the West* and *The Apple Dumpling Gang*. “Don Knotts was a huge part of *Rango*,” stated Hickel. “Also, Hunter S. Thompson—and, specifically, Johnny Depp’s take on Thompson—was a big influence on the character.”

Creature development lead Brian Paik was responsible for *Rango*’s rigging, including controls for animating his long, bent neck and tail, which became key to expressing his emotional state. *Rango*’s most expressive features, however, were his chameleon eyes. “Gore and the designers had taken a huge risk with *Rango*’s eyes,” stated Hickel, “which were really odd and interesting. From the beginning, *Rango*’s eyes were a worry to everyone—and even to them—because they were so small. There’s a reason that most cartoon characters have huge glassy eyes, which is that those kinds of eyes are very expressive and make it easier to get an emotional read on a character. But most of *Rango*’s eyeball is covered by flesh, with only little openings. So it was a risk, but it



Having been promoted to sheriff, Rango, flanked by the orphan girl Priscilla (Abigail Breslin) and the town’s mayor (Ned Beatty), responds to a bankrobbery in which the vault has been emptied of its treasure – in this case, precious water. Priscilla was based on the aye-aye of Madagascar, while the desert tortoise mayor was modeled after John Huston’s character in *Chinatown*. The designers – and later, the animation team at ILM, led by Hal Hickel – often referenced iconic film characters in developing

turned out to be one worth taking, because his eyes are very successful. The fleshy wrinkles and rings around his eyes gave us all kinds of opportunity for

*physical characteristics and behaviors for Rango's townsfolk.*

expression. Of course, it was a pain in the butt, technically, because every time his eyes looked to one side, the eye on that side would dig into his eyebrow ridges; and so, we had to have all kinds of little correctives under the hood, little automatic things to keep the flesh from penetrating.”

Rango’s small eyes were a contrast to the large, glassy and deeply refractive eyes seen on characters such as Beans and Priscilla, the little orphan girl. Modeled on real animal eyes, these naturalistic ‘doe’ eyes were just another way in which the characters in *Rango* were distinctive from those in most animated films—but they would create untold problems for the animators. “If you look at most animated features,” said John Knoll, “everybody does the ‘Pixar eye,’ which is a big white sphere with an iris on the front that has a concave shape. I’d always wondered, ‘Why don’t people do more interesting, deep, realistic eyes on animated characters?’ And now I know—it’s because they’re a giant pain in the ass!

“Eyelines are very important in animation; and the problem we ran into was that the refraction of these deep, glassy eyes affected pupil size and direction a lot. So, for example, Hal would get an animation of Priscilla approved with Gore; but then, when we rendered it, it looked as if she wasn’t looking at the other character. Her gaze direction would be way off, and the size of the pupil would change. We suffered with this for a very long time before coming up with a solution. It drove us crazy.”

“That was an interesting technological and creative problem to solve,” Hal Hickel agreed. “Our characters’ eyes were modeled as a spheroid with a cornea lens over the top of the pupil opening. And we were actually rendering that cornea lens with ray-tracing to get the distortion that lens has on a real pupil. That’s what gave us that nice deep-looking eye with highlights and everything. But what it also did was distort the pupil so much that the animator couldn’t really see what it was doing when he was animating it. In Maya, it was just a clear glass shell over the pupil, and the pupil wasn’t distorted or magnified at all. So the animator would carefully adjust the rotation of the eyes to get a certain eyeline; but then, once it went off to lighting and rendering, and there was real refraction applied to that cornea, the pupil would shift into a different spot because of the magnification of the cornea, and the eyeline would be off.

“Finally, digital production supervisor Jason Smith came up with a clever deformer in Maya that attached to the eyeball. It would deform the pupil based on its angle to the camera and on some index of refraction in the dome of the cornea, so the animator could see what was going to happen to the pupil after it had been rendered. The animator could just aim the eye, turn this tool on, adjust



*Rango and his posse prepare to track down Bad Bill and his gang. To create the hot and dusty look of daytime exteriors, ILM composited in layers of atmospherics and executed artful lighting, referencing similar shots in Paul Thomas Anderson’s *There Will Be Blood*. ILM’s effects animation group created the film’s ubiquitous dust effects using Plume, a fluid simulation tool the team had first developed for the elemental effects in *The Last Airbender*.*



the eye direction to account for the refraction, and know that what he was seeing in his animation was going to look exactly the same when it was fully rendered.”

As animation lead for Beans, Maia Kayser dealt with the eyeline problem throughout much of the animation period, as well as the unique challenges presented by the character’s hair. “Ordinarily,” said Hickel, “hair is handled by the creature dev group, after we do our animation; but we really needed to know how the hair was going to move while we were animating Beans. If she tossed her head, we needed to see how her curls were going to bounce around and how her bangs were going to move. So James Tooley’s creature dev group, and most specifically, Brian Clark, set us up with some great controls that worked in Maya so that the animator could animate a shot, and then run a quick little sim to see what the hair would be doing. We did the same thing with Priscilla’s braids and a few other characters with a lot of hair.” Kevin Reuter was the main look development person behind all the final hair simulations.

Shawn Kelly led the animation for the mayor, looking to John Huston’s character in *Chinatown* for inspiration. “Ned Beatty, who did the voice for the mayor, seemed to be channeling Huston’s character from that film, too,” Hickel commented. “The John Huston character gave us a really great hook to build him on, and he ended up being a great heavy. After we finished his animation, the creature dev guys did some very nice flesh sims under his chin so that his jowls would wobble back and forth. The other thing we had to figure out was the animation of his wheelchair—which was this spring-wound, Rube Goldberg contraption—and how all the little mechanisms should work.”

Animation for Rattlesnake Jake was led by Jakub Pisticky, who also helped to set up Jake’s rigging, which was particularly complex due to the character’s undulating scales. “If the body stretched,” stated Hickel, “we wanted the scales to separate slightly. If the snake body contracted, we wanted them to fold over one another, and not penetrate or pass through. That was a nightmare and a lot of hard work by Keiji Yamaguchi—one of our most brilliant riggers—Jakub, the modelers and the people in the creature development department. Jake was probably the toughest character to rig and get ready for animation.”

Fifteen years before the *Rango* project, Hal Hickel had left Pixar—after a stint as an animator on the first

*Toy Story*—to join the ranks at ILM, as his interests had always fallen along the visual effects/Ray Harryhausen lines. But his work on *Rango* reminded him of the joys of pure animation, of creating a performance untethered to a live-action plate or performer. ILM’s technical directors, too, were freed from the constraints of a live-action plate as they developed lighting for *Rango*’s sequences.

“One of the great creative outlets for me on the show was being able to direct lighting,” commented Tim Alexander. “Lighting is a creative process with visual effects, too, but there’s a DP involved who



*For a sequence in which Rango and his posse explore underground tunnels in search of a water source, ILMilluminated the dark, cavernous 3D digimatte environment with only torches carried by the characters. For reference, the crew looked to Verbinski’s Piratesfilms, which featured many torch-lit scenes. ILM’s lighters went for an authentic photographic look for the sequence, exposing for the characters’ faces, which blew out the torchlight. The effects team used their Plume simulation to generate the torches and all the fire effects in the film.*

has made a lot of decisions up to the point at which we get the plates; and those decisions dictate what we can do with our lighting. With an animated feature, it was a completely open palette.”

Though not tied to actual live-action plates, the ILM artists were asked to adhere to a live-action aesthetic in the lighting—which was right up their alley. “I always knew that the lighting would be great because the default ILM lighting is so much more real than what you see in any animated movie,” Gore Verbinski said. “I mean, they turn on that sun, and you go, ‘That’s ILM’—immediately. So keeping it raw and real in the lighting I knew would be a no brainer with ILM; and I knew it would give us something unique, because that kind of lighting just isn’t seen in animated films.”

To ensure a live-action look, Verbinski brought on as a consultant director of photography Roger Deakins, who pulled photographs from films with the appropriate lighting to give the ILM TDs guidelines. *There Will Be Blood*, especially, became a benchmark for the lighting in *Rango*. “*There Will Be Blood* is a beautifully photographed film that has a lot of the same settings we were dealing with,” said Tim Alexander, “hot, dusty daytime exteriors, campfire scenes, nighttime scenes, all of which were applicable to *Rango*. The look and the brightness contrast ratios in one of our first shots in the town of Dirt, where *Rango* and Priscilla have their first little exchange, were cribbed directly from a scene in *There Will Be Blood*. It really helped to find a reference that felt exactly right.”

The daytime sequence in which *Rango* first enters the saloon was among the most complex in terms of lighting. “Gore really wanted it to be gritty and atmospheric, for one thing,” stated Alexander. “And because of how the scene went, every single shot had to be lit on its own. We couldn’t reuse the lighting from one shot for another one, as we were doing in a lot of the sequences. So I knew that the saloon was going to be a very complicated lighting sequence. We again pulled references from movies that had the type of lighting we thought we could use.”

Effects lead Dan Bornstein developed a technique to generate atmospherics, as sunrays from outside the saloon broke into the gloom of the seedy interior.

“There were all these light beams coming through,” said Mike Bauer, “and we were able to precisely control where those light beams would go, and how the particulate atmospherics would flow across the characters and through their hair. The development work on that was amazing.”

A midday scene immediately following the saloon sequence, in which *Rango* goes out into the street to engage Bad Bill (Ray Winstone) in a gunfight, helped to establish the hot, daytime look of the desert exteriors throughout the film. “It was a seminal sequence in terms of our outdoor look,” said Tim Alexander, “and we looked at *There Will Be Blood* as well as the Sergio Leone films to get a handle on it. For example, we were looking at how they would light people with hats on, which is a difficult thing to do without winding up with a lot of shadows on the faces.”



*Rango* and crew look out over a Monument Valley-style vista in a shot that conjures iconic images from the films of John Ford. As a cost-savings measure, Verbinski had started the project with the intention of leaving backgrounds more or less abstract, saving the detailed environments for those immediately surrounding his characters. As ILM started to assemble shots, however, the filmmaker determined that even distant backgrounds required a high level of detail to fit into *Rango*’s ultra-realistic world.

A sequence in which *Rango* and his posse explore underground tunnels in search of a water source required a very different kind of lighting because it was a dark, cavernous 3D digimatte environment illuminated by torches. The crew looked to none other than Gore Verbinski's *Pirates* films to find reference for torchlit shots. "The *Pirates* films are full of torches," observed Alexander. "What we were going for in this sequence was a real photographic look. If we were actually shooting this scene in a tunnel, the torches would be blown out because we would be exposing for the characters' faces; and so, that's what we did in the animated scene." Effects supervisor Raul Essig and his team simulated the torches, and all the fire in the movie, using *Plume*, a fluid simulator ILM had developed for *The Last Airbender*. *Plume* was also used to create the film's ubiquitous dust effects.

The effects animation group generated gunfire, dynamite explosions, debris and all manner of dynamics for the film's big action sequences, such as the 'bat attack.' "The bat attack is a big, classic western chase," explained Mike Bauer, "where bats armed with machine guns chase *Rango* and his posse through a deep canyon. Michael Jamieson did great work on the dynamite explosions; Joakim Arnesson and Florian Witzel did fantastic work on the dust trails that are kicked up in the chase; and Jeff Grebe created all the debris. Combining the debris with complex dust simulations and tracer fire and explosions all added up to a very dynamic and realistic-looking action sequence."



*ILM's effects animation group generated gunfire, dynamite explosions, dust and debris for the film's big action sequences, such as one in which gang members on bats armed with machine guns attack *Rango*, Beans and members of the posse aboard a Conestoga wagon. ILM compositors adjusted focus and depth of field in shots rendered in separate layers, as performing such tweaks in compositing was more efficient than rendering a shot in its entirety, with focus and depth of field settings baked in.*

Densities involved in effects animation, highly detailed characters and environments, and extremely complex lighting all added up to a tremendous rendering burden. To manage renders as efficiently as possible, ILM devised a system to automatically split out specific elements to render in separate layers. "Basically," said Mike Bauer, "we took it out of the artists' hands and into the technology. That was especially crucial for very complicated shots. So, for example, if you've got a shot with 30 characters, the system knew what to split out so that when it was loading the stuff to render, it only loaded what was needed. We'd be working with the entire scene at our desk; but when we rendered it, it would be broken up into lightweight, bite-sized pieces. To make Character 1 look right, we might need the hair to run, and ambient occlusion here, and shadows—but we would also need the influence of Characters 2, 3 and 4 to get the proper indirect lighting onto it. The system could figure out that it needed Character 1, these three other characters, and these few other items—and that's what it loaded and sent to render. It was a very modular approach to rendering our work."

"The memory involved in rendering some of these characters was so high we had to put them in smaller groups," Tim Alexander added. "That is the ILM mentality—if you render in layers, it takes a bit more management to put them together; but if you've got an error in one of them, you don't have to re-render everything. So it made sense to run out multiple layers, and then do defocusing and depth of field and other adjustments and tweaks in the comp. There was a lot of problem-



solving that kept falling further and further down the line into compositing, because that's often the most efficient place to do it."

As finals accumulated, Gore Verbinski and Crash McCreery were gratified to see their character and environment designs come to vivid life on screen. "The more we asked for," said Crash McCreery, "the more ILM delivered—and the more they inspired us to go further, to keep digging deeper, enriching the characters and environments more and more. Everyone's efforts fed into this wonderful organic process. Even though a lot of detail would be lost in shadow or obscured by atmosphere, we knew that the viewer would still feel it was there. Everybody was on board with that, and no one ever compromised one pixel of what was designed. The world we created had to be convincing enough for the audience to accept it and allow themselves to be immersed into the story."

The end product of all the work put in by Gore Verbinski, his team of artists and writers, and the crew at ILM is an animated film unlike any other—distinctive and, as Verbinski had hoped, 'singular.' That it is an animated feature is, in fact, entirely beside the point. "I don't look at animation as a genre," said Verbinski. "I look at it as a technique to tell a story. People tend to think of animation as what comes out of DreamWorks or Pixar, but it can be anything. It's really no different than live-action in that way. It's a form of communication.

"But there are big differences, too, and the biggest is that everything in animation is manufactured—every blink, every scratch of the chin. Nothing just presents itself to you as a gift. Live-action, on the other hand, is chaos—but you get many, many gifts out of that chaos. You put the actors together in a room and you let them go, and as you're photographing them, you're searching for the moment when the actor leaves the page and reacts honestly. Your camera is like a butterfly net, and you are waiting to capture that moment of truth or the little anomaly. And when those happen, you grab them and hug them because they're wonderful. That's what we tried to bring to *Rango*—all the spontaneity and awkwardness that you get when you're shooting a live-action film. I think we accomplished that, and that's what will set *Rango* apart."



*With the exception of a black hat, eyelids and a bandolier wrapped around his body, Rattlesnake Jake (Bill Nighy) was designed and rendered to look like a real-world rattlesnake—although the designers also took inspiration from Lee Van Cleef's reptilian character in *For a Few Dollars More*. Prior to sculpting and rigging the character, the ILM model crew studied snakes at the Academy of Sciences in San Francisco to gather authentic nature reference. Animation rigging for Rattlesnake Jake was particularly complex due to the character's undulating scales, each a separate piece of geometry.*

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# Aliens in the City of Angels

image

BY JODY DUNCAN

Visitors to the Sony Studios backlot in January 2009 may have come upon a half-dozen *Marines* in full grunt uniform and buzz cuts engaged in gun battle against an invisible foe amidst the debris of a new construction area. Director Jonathan Liebesman was shooting the military-garbed performers for a three-minute test he hoped would earn an official greenlight for *Battle: Los Angeles*, an action film written by Christopher Bertolini, about a squad of *Marines* fighting against alien invaders.

In the months leading up to the test shoot, Liebesman had worked with producer Jeffrey Chernov, conceptual designer TyRuben Ellingson, and visual effects supervisor Everett Burrell to design shots and choreograph action, all aimed at illustrating for studio executives the intended visual style of the film. “We were all in a little room at Sony,” Burrell recalled, “throwing out ideas and coming up with a game plan. Then, on a weekend in January, we got a couple of RED cameras and shot it at Sony, which, due to construction on a new office building, looked like a bombed-out area at the time.” Aaron Eckhart, who would star as Marine staff sergeant Michael Nantz, was among the performers in the test. “He was a real trooper. He came dressed as a Marine, with his hair cut and everything. We also had a bunch of actor friends, and some smoke machines and pyro gags, and we shot the whole thing in the action style Jonathan wanted to do for the film.”

Over the next six weeks, Liebesman cut the short film, while Burrell orchestrated visual effects contributions by Spin VFX, Hydraulx, Rhythm & Hues and Sony Pictures Imageworks, all of which created shots for little or no remuneration. Spin’s contribution was especially vital, as the company was tasked with creating the alien for the test, based on 2D designs by concept artist Paul Gerrard. “We went through several iterations of creature building,” recalled Spin visual effects supervisor Jeff Campbell, “because the design evolved from a quintaped to a biped alien. We did a lot of motion study work, as well, providing walk cycles and animating action scenarios. Our version of the alien creature was about 75 percent of where it wound up in the final movie.”

Spin did three shots of the aliens, using motion capture to drive the animation of the essentially humanoid characters. The other vendors provided atmospherics, environment enhancements and pyrotechnics to augment what had been photographed on the backlot, with Liebesman and Burrell executing many of the final composites. “Jonathan likes to do visual effects stuff himself,” said Everett Burrell, “working in After Effects, Photoshop and Maya.”

In March 2009, Liebesman presented the short to Sony Pictures chairman Amy Pascal, who was enthusiastic about the potential it revealed for *Battle: Los Angeles*. “She loved it,” Burrell recalled. “It was just this little three-minute piece, but it was very dramatic, with some choice visual effects and great music. It also established the guerrilla, hand-held feel of the film, as if the cameraman was right in the middle of this platoon of *Marines*. Between that test and the phenomenal efforts of producers Neal Moritz and Jeffrey Chernov, we got the film greenlit in June 2009.”

The design of the alien protagonist had been an ongoing effort up to that time, and would continue well into production, and even postproduction, as designers and effects artisans strove to meet Liebesman's challenge to come up with a creature that was not at all derivative. "Jonathan wanted a unique take on the aliens," observed Burrell. "He wanted something very different, and yet completely real—and that's what made it so difficult. Even before I came on, he and Paul Gerrard had explored a variety of ideas—a weird undersea squid type of alien and different versions of the more humanoid alien. Just to get some ideas, we had *Spectral Motion* do a sculpture for us, and Jordu Schell did some maquettes, as well. We went through hundreds of designs before Jonathan started honing in on one, which was a nine-foot-tall, hybrid organic/robotic alien with a right 'arm' that was actually a weapon. It was 80 percent there by the time the shoot started, but Jonathan continued to refine that design throughout the production."

The preproduction period also bore alien hardware designs by TyRuben Ellingson, who had designed much of the hardware for *Avatar*, as well as storyboards and previz, the latter generated by David Dozoretz's Persistence of Vision previsualization team. With the official greenlight, the crew began scouting locations in Louisiana, where the production would be based, and Burrell engaged visual effects vendors, ultimately awarding shots to Cinesite, Hydraulx, Spin VFX, Luma Pictures, The Embassy, Soho VFX, Shade, Matte World Digital and Intelligent Creatures.

To help plan shots, Burrell also hired an in-house effects crew, unofficially dubbed 'The Garage Band.' "It was a team of eight guys," explained Burrell, "led by compositing supervisor Robin Graham, and they did a phenomenal job helping us come up with a guide for the outside vendors. And then, when that work ran out, they started doing a lot of the shots you see in the trailer, such as those of the aliens invading cities around the world. Jonathan would rough them out first, doing an initial comp in After Effects, and then our in-house guys would take it to the next level. They filled in cracks that arose in editorial, as well, as Jonathan came up with new shots. Jonathan's approach to this movie was very organic, so we had to have a post-viz team to help him. I can't praise those guys enough; they did a great job of serving the creative process of making this movie."

Cinesite was the first vendor brought onto the show, largely due to Liebesman's admiration for the company's Emmy award-winning work on the HBO Iraq War film *Generation Kill*. Cinesite had produced gritty, hyperrealistic shots of combat and an overall 'fog of war' for that show, which was just what Liebesman wanted for his documentary-style *Battle: Los Angeles*. Though Cinesite would have some hero alien shots, most of its work would involve reveals of war-torn Los Angeles—some created as full CG environments—and combat sequences featuring rendered military hardware, tracer fire, explosions and smoke.

Burrell assigned Hydraulx, another principal vendor, most of the alien-related shots. Hydraulx built the alien model based on the Paul Gerrard concept art and a final alien maquette. "We studied that physical model in detail," recalled Hydraulx visual effects supervisor Bill Kunin, "and our lead modeler, Yoshiya Yamada, matched it exactly. We had some liberty in terms of what was an organic material and





what was a functional metal piece. On the physical model, some of the metal stuff looked like it was painted on, and we had to determine if we should paint it on our computer model or model it as a moving metal piece.”

Initially, the Hydraulx artists were unsure as to the level of detail required on the alien model since, at this early stage, camera proximity from shot to shot had not yet been determined. “We didn’t know if we were going to get right up into its face,” remarked Kunin, “or if it was never going to be closer than a medium. We knew there were going to be a lot of medium-to-wide shots, but we had to prepare for the chance that there might be an alien walking right by camera, closer up. So we detailed it out pretty thoroughly, adding small metal pieces on the foot and other bits. We modeled it in Maya and rendered it in mental ray. We do a lot of proprietary coding for builds, but we needed to make sure that everything for the alien would transfer easily straight out of the box, in Maya, because we were going to be sharing the asset with several other vendors.”

Hydraulx animation lead Joel Sevilla and his crew conducted animation tests to develop the creature’s movement, which would be essentially humanoid, but with a clunky mechanical feel. “From the beginning, Jonathan didn’t want some sort of creature-y type of movement,” said Kunin, “but we did some tests and experimented with that idea for a while, just to give him options. Eventually, we went back to the original concept of an alien that moved like a human biped.”

The film opens with a wide aerial shot, executed by Cinesite, of a ravaged and burning Los Angeles, with CH-46 helicopters and A-10 Warthogs flying towards camera. Under the guidance of visual effects supervisor Ben Shepherd, visual effects producer Jennifer Mizener, 3D supervisor Anthony Zwartouw and 2D supervisor David Sewell, Cinesite artists added all of the destruction, smoke and fire to an aerial plate of downtown Los Angeles. “We did a digital reprojection of a matte painting to show the low-level street damage,” said Ben Shepherd. “We also built up columns of smoke—all done with Maya Fluids and volumetric lighting—and comped in both 2D and 3D fire elements.” The Cinesite crew had to be judicious in its use of CG smoke, as Jonathan Liebesman had indicated a preference for practical smoke elements, asserting that he could always spot CG smoke, no matter how well done. The effects team took that as a challenge. “You can do CG smoke simulations now that you couldn’t have done even a year ago. A year or so ago, Maya Fluids went multi-threaded, and now it just flies. We could stick our Maya Fluids simulation on the renderfarm, with thousands of CPUs doing complicated fluid renders, and things that would have taken weeks to do previously came back overnight—and they were twice as good! I’m happy to say that Jonathan never quibbled about the CG smoke in this shot.” Cinesite also generated the CH-46 helicopters and A-10 gunships in the shot, reconfiguring Generation Kill assets to fit the specific requirements of *Battle: Los Angeles*.

*Director Jonathan Liebesman enlisted visual effects supervisor Everett Burrell and a host of visual effects vendors in the United States, Canada and England to create the fast-paced, documentary-style Battle: Los Angeles. The action film follows a squad of Marines as they engage alien invaders in an existential battle. Liebesman shot the film at various Louisiana locales, then relied upon visual effects teams from Cinesite, Hydraulx, Spin VFX, Soho VFX, Luma Pictures, The Embassy, Shade, Matte World Digital and Intelligent Creatures to supply Los Angeles backgrounds, alien creatures, military and alien aircraft, and widespread urban destruction.*

After a legend that reads ‘24 Hours Earlier,’ the film cuts to Camp Pendleton, a Marine base in Southern California, where Sergeant Nantz and his squad watch news reports of what appear to be meteorites landing in the ocean near Santa Monica beach. Cinesite realized shots of the meteorites falling into the sea for this and subsequent scenes, creating an interesting airbrake effect just prior to the objects’ making impact with the water—an important story point that suggested these ‘meteorites’ are actually a type of alien ship.

A massive practical explosion, executed on location in Louisiana by special effects supervisor Stan Parks for a final battle sequence, had produced an unusual smoke-ring formation that became the inspiration for the look of the retro-thruster airbrake effect. “One thing about shooting in Louisiana,” Ben Shepherd commented, “they don’t mind how big you make your explosions; and so the special effects guys were going crazy out there. I swear that there are shots in the movie where you see Aaron Eckhart duck behind a fireball—because he’s really ducking behind a fireball! One day we looked up and there was this massive black smoke ring, 20 meters across, going up into the sky. Everett turned to me, and said, ‘If you did that in CG, nobody would believe it.’ And then Jonathan said, ‘I want that in my film!’ So that was the birth of the airbrake smoke ring—this impossible effect that nobody would believe. We did it using Maya Fluids; and a very talented TD named Claire Pegorier spent ages on that effect to get it just right.”



*In response to the attack, combat Marines – one squad under the command of staff sergeant Michael Nantz (Aaron Eckhart)– are deployed from their base at Camp Pendleton to a Forward Operating Base the military has established at Santa Monica Airport. To aerial plate photography of three CH-46 helicopters flying over Los Angeles, Cinesite visual effects supervisor Ben Shepherd and his team inserted additional helicopters and aircraft, plus billowing smoke and fire effects. Cinesite also realized a shower of meteorites – actually alien vessels – plunging into the sea in the background, devising a smoke-ring airbrake effect that kicked in just prior to the ships’ impact with the water. Cinesite sweetened the shots with CG meteor trails and water splashes.*



*As the Marines near their destination, Cinesite artists augmented the live foreground helicopters photographed by Everett Burrell over the Santa Monica Pier and beach areas with computer generated helicopters, CG smoke, and fire elements – both practical and CG.*



*Aboard one of the transport helicopters, the Marines get a view of the area under siege below. Cinesite added smoke and fire and vehicular chaos to live-action plates shot in*

and around Santa Monica and along the California coastline. The main ones of this kind are the Marines' use of a Mardian gas canister for them to end a single helicopter for site if it does smoke that fuel and as the chopper lifts off, no plates, so alien drone ships. So the ship is a white globe, the CG is a white globe, setting the aircraft aflame and causing it to crash and explode. Soho visual effects supervisor Keith Sellers and his crew realized the nine-shot sequence, making the transition from a live-action helicopter to its CG version after lift-off, and incorporating a CG alien drone – modeled and rendered by The Embassy – into live-action plates shot in Shreveport. Soho also integrated practical explosion elements combined with fluid simulation effects and digital debris.

As the news report continues, the close-range impact of one of the alien ships causes the capsizing of a Coast Guard cutter, which is boarded by dark, indistinct shapes. Smoke-enshrouded aliens then invade the beach, firing phosphorus-emitting weapons as panicked crowds disperse. Spin was called upon to execute the dramatic first invasion sequence. "Jonathan wanted to keep the creatures mysterious in these shots," said Jeff Campbell. "He loved to see them silhouetted in CG smoke, which gave us these great menacing shapes." The Coast Guard cutter capsizing shots were all CG, and incorporated Realflow fluid sim effects and Cinesite's meteorite and water explosion elements. For the panicked crowds, Spin used greenscreen plates of running people, projecting them on cards in Nuke's 3D environment. "We used Massive for the wider crowd shots where 500 people were being slaughtered by the aliens' phosphorus gun."

Much of the film's narrative would be relayed in such broadcast news reports, and the two-year-old Shade effects house was responsible for treating and compositing imagery into blank television screens and monitors throughout the show. "There are a lot of shots of people watching television to see what's going on in the outside world," noted Shade visual effects supervisor Bryan Godwin. "We made sure that those shots had a real-world feeling, both in the graphics overlays that we made and in how the footage was treated so that it would look and feel as if someone was really out there in the middle of the chaos. On the set, they either blue- or greened-out the screens and monitors; and in some cases they did neither, and so we just had black screens. For the most part we would get effects plates from other facilities and then embed those into the screens. As the edit continued, though, they kept finding ways to extend the story with news conferences or reports, and we wound up creating some new shots and applying the television look to them with banners and graphics.



Spin VFX, under the supervision of Jeff Campbell, produced a CG matte painting for a later sequence in which the Marines traverse downtown Los Angeles in search of shelter in the aftermath of another major battle. Production shot the actors against greenscreen in Shreveport; but other than the live-action Marines, everything in the shot was computer generated. To create images of a destroyed Los Angeles, Spin artists started with a production-approved still of the designated L.A. area and then painted destruction effects in Photoshop. Spin also added a crashed alien saucer in the foreground, columns of smoke, and military and alien ships engaged in a dogfight in the distant sky.



“For example, there are a number of news reports showing downtown L.A. getting blown up and destroyed. We got really low-rez footage of Baghdad or some other war-torn area, and did some matte painting to make that look like downtown L.A., also adding in flak and tracer fire and so forth. Some of these were clips from YouTube that were literally only 200 pixels wide, and we had to rez them up to 2K. We’d use those clips as the basis and then create a matte painting, reapplying a video filter to make it look like something broadcast on TV—but, of course, it still had to hold up at full rez.” Shade also did some background replacement for the Camp Pendleton scenes to make the Louisiana location look more like Southern California, and provided graphics for heads-up displays and military hardware interiors throughout the film. “We worked mostly in Photoshop for the graphics, but we did all of our compositing in Nuke.”

The *Marines* are deployed to a Forward Operating Base that the military has set up at Santa Monica Airport. Cinesite executed the sequence, which starts with the forces mobilizing at Camp Pendleton and taking off in several CH-46 and Huey helicopters, and then cuts to the aerial view of the coastline below. “For the big Camp Pendleton establishing shot,” said Ben Shepherd, “they had shot a flight control tower at an empty airport in Louisiana, with three helicopters on the ground and one Huey flying past. We had to populate that airfield and create a much bigger, much more chaotic and busy environment.” In addition to adding military vehicles and aircraft to the establishing shot, Cinesite augmented aerial plates of three real helicopters in flight with CG CH-46s to create a larger body of helicopters flying in formation over the coastline.



*The Marines take cover in an abandoned police station, where two of them make their way to the roof and use their military scopes to check out alien activity in the distance. Scope views reveal infantry aliens unloading cargo, directed by a squid-like alien general. Cinesite modeled the general for a later sequence, then shared that asset with Spin, which executed 35 shots for the rooftop sequence. Spin artists used motion capture to drive the animation of the general’s upper body, but keyframed the character’s tentacle-like legs to move in a floaty manner, as if under water.*

From their aerial point of view, Nantz and his crew see the devastation of previously lost battles below, the beach dotted with crashed military aircraft and dead and burnt victims of the alien invaders. Cinesite created the shots of the carnage on the beach. “There is a crashed alien ship there, as well,” explained Shepherd, “but we had to disguise it because the alien ship hasn’t been introduced yet at this point in the story. We also added all the crashed helicopters and miscellaneous burnt people, which we did with Massive and a little bit of digital matte painting to tidy it up. There was also a combination of live-action and 3D smoke elements in the shots.”

Cinesite also executed subsequent shots of the airborne helicopters dodging a shower of alien ship meteorites and a ground-to-air attack from aliens below. The action then cuts to the street level, where a battle is in progress between a platoon of *Marines* and the aliens—still shadowy figures, not yet fully revealed. “The aliens use a fog bank as a screen as they move forward,” remarked Shepherd, “so you can’t quite see what’s going on. There are also miscellaneous explosions going off, producing smoke, which we did with 3D fog systems. Every time a bomb would go off, we would

set off a little concussion field going through it to push the smoke out of the way, so we would reveal a glimpse of some dead bodies or burning cars and that sort of thing.”

Cinesite populated the shots with the Hydraulx alien, animating the characters based on motion capture sessions that Everett Burrell had conducted at Giant Studios with two tall performers. “We had a library of motion capture for all the aliens,” stated Shepherd, “and we used that in some of the shots; but the big closeup stuff was all keyframe animation. Jonathan’s idea was that the aliens looked human enough so that at a glance or from a distance, you might think they were humans. They move like us, and walk like us, and duck when they’re shot at. So they were very organic and human in their movement, but they also had distinctive mechanical characteristics—little glitches and twitches that were very deliberate.”

Shots of the *Marines* arriving at Santa Monica Airport required more Cinesite enhancements of military aircraft and hardware to add an appropriate level of activity to a plate shot at a small airport near Baton Rouge. Cinesite also added background explosions and smoke on the horizon to suggest a battle in progress nearby.

Assigned the mission of rescuing and evacuating civilian survivors of a previous battle, the *Marines* head out from the FOB, and soon find themselves ambushed by the aliens. Liebesman had shot the ambush scene in his war-documentary style, and delivered those ‘handicam’ style plates to Luma Pictures, which was responsible for integrating the alien forces into the scene. “Luma added in these dark alien shapes in the smoke,” observed Everett Burrell, “very subtle and blurred. Jonathan wanted to make it almost like a scene from *Platoon*, where you would see a Viet Cong soldier off in the distance. He wanted to just see shapes, not detail.”

Luma artists reconfigured the Hydraulx alien asset to make it work within their pipeline, and then integrated aliens into plates of empty rooftops where the creatures should be. “These plates all had very fast actions,” recalled Luma visual effects supervisor Vincent Cirelli, “with swift camera pans from actors to rooftops and rooftops to actors to convey the crossfire. We blocked out exact lines of sight and how many aliens would be on the rooftops and so forth.”



*Production shot the actors on a real rooftop in Shreveport, with the intention of incorporating appropriate backgrounds in post. Initially, the sequence was designed in such a way that only a couple of small matte paintings would have been needed. However, as Liebesman finessed the film in editorial, he recognized that an entire vista of Santa Monica under fire would be required. Spin created the view as a 270-degree multiplane matte painting built in Photoshop and Nuke. Spin artists then tracked the digital cyclorama into the plates – a painstaking process due to the film’s handheld camera work.*



To realize the 50 shots as efficiently as possible, Luma pre-rendered the ambush sequence aliens. “We set up a series of Nuke gizmos to propagate these pre-rendered aliens into shots,” said Luma CG supervisor Richard Sutherland. “We did a variety of camera angles, and the compositors could pick from a wide library of actions and angles to populate the plates with these aliens directly in Nuke, which has a sophisticated 3D system of cards, geometry and camera tracking. We quickly got through a lot of shots that way, having compositors do their own camera tracking, and then using these pre-built gizmos to put aliens on some of the tracking points that they’d developed. We also included extra render passes for those pre-made aliens, so they could adjust the lighting on each shot—shift the lighting angles, increase the specularity and so forth.”

*Production shot the actors on a real rooftop in Shreveport, with the intention of incorporating appropriate backgrounds in post. Initially, the sequence was designed in such a way that only a couple of small matte paintings would have been needed. However, as Liebesman finished the film in editorial, he recognized that an entire vista of Santa Monica under fire would be required. Spin created the view as a 270-degree multiplane matte painting built in Photoshop and Nuke. Spin artists then tracked the digital cyclorama into the plates – a painstaking process due to the film’s handheld camera work.*



*For a sequence in which the Marines find an injured alien and then dissect it to determine how best to kill their adversaries, creature and makeup effects supervisor Joel Harlow and his crew created two practical infantry aliens. Harlow’s team sculpted the nine-foot alien in clay, and built the final puppets out of silicone, fiberglass, and found machine and computer parts to suggest the creature’s biomechanical composition. Harlow inspects the full-size alien sculpture.*



The smoke that obscures the aliens in the scene was primarily practical, generated on the set, with some CG enhancements added in post. “Jonathan referenced footage from 9/11 for that look,” recalled Everett Burrell. “After the two towers collapsed, there was this really thick, ominous smoke hanging in the air, which had an eerie look.”

Luma added a dark, oily CG smoke and integrated it into the smoky plates. In addition, the company composited in smoke elements shot by Burrell during production. “These were beautifully shot elements,” said Vincent Cirelli, “which we were able to put into Nuke gizmos and place appropriately throughout the scenes. We also augmented the plate photography to show destruction. For example, if they blew up a newspaper stand, we would either reveal a matte painting or a 3D object of whatever type of damage was needed, adding bullet holes and the like to the newspaper stand.”

For tracer fire, Luma worked from a preliminary Nuke setup that had been done by the in-house production effects team. “We ended up doing a lot of tweaking on it,” said Richard Sutherland, “but it all stemmed from that initial setup that we got from production. Through-out the development, there was quite a bit of thinking as to how to differentiate the human tracer fire from the alien tracer fire. The sequence was supposed to be fairly confusing overall—very smoky and chaotic—but it also had to be clear as to who was shooting at who, and who was being hit, and the tracer fire was the primary way to do that. It came down to there being more irregularity in the alien tracer fire and more of a linear look to the gunfire coming out of the *Marines*.”

A Huey arrives at the ambush site to airlift out some wounded *Marines*; but as the helicopter lifts off, alien drone ships fly overhead and open fire on it, destroying it and killing all on board. The sequence, realized by Soho VFX, offers viewers the first good look at the 20-foot-long alien drone ship, designed by TyRuben Ellingson and then modeled and rendered by The Embassy. Production provided The Embassy with a Gentle Giant scan of a drone maquette. “We used that scan data as a guide,” noted Embassy visual effects supervisor Winston Helgason, “but we rebuilt everything because Jonathan decided that the shapes on the maquette were too angular. We softened some of the edges in our model and made it a little more dynamic. We added a lot of exterior detail, as well—hoses and things like that.”



Crew member Lenny MacDonald finishes one of the alien torsos created for the live-action shoot.

The company also received a drone weathering pass from Paul Gerrard. “Jonathan wanted the alien hardware to look distressed and weathered,” said Helgason, “as if it had been in a lot of battles. We had one of our designers, Andrew Domachowski, do some work on it, as well. The idea was that the aliens are coming to this planet after stopping at five other ones along the way, and so there are existing laser blast scars and holes in the ships, along with a lot of grime and oil streaks.” Lead modelers Dan Prentice and Paul Copeland used Modo for modeling the drone, which was then animated in XSI and rendered in mental ray. The Embassy would also build the 60-foot-diameter saucer ship, a circular aircraft made up of eight of the triangular-shaped drones, tweaking the surfaces of each drone in the formation to avoid a cloned look.

An interesting characteristic of the drone ship was its thruster pattern, which was based on reference Jonathan Liebesman had found on YouTube of the real-life ‘Multiple Kill Vehicle,’ a NASA jet-propelled satellite used in rocket defense. Embassy artists Paul Flanagan and Robert Kelly developed the thruster effect in Houdini. “In the reference,” related Helgason, “we saw that this satellite had a very interesting type of firing power that made it move around in space, and we adapted that to work for the drones. The drone was lifted by four main downward thrusters firing in a staccato pattern; and there were also eight control jets around it that were constantly firing. It didn’t have any kind of aerodynamics—it was all based on these thrusters keeping it aloft and changing its course. Developing that was a lot of work.”

Liebesman’s further brief to The Embassy regarding the drone’s flying style was that it should look as if the alien ship’s technology did not work at full capacity in earth’s gravity. Animators conveyed that idea by having the ships fly more or less smoothly at high speeds, but more roughly, with fits and starts, at slower speeds. “When the drone is hovering down a street,” noted Helgason, “it almost looks like a big V-8 engine running at low idle. It’s moving with all these imperfections, always



*Among the practical aliens built by Harlow’s team was an upper-body puppet that could be worn on the chest of one operator, who provided gross ambulatory moves, while a second operator effected head and limb movements from behind via external rods. Though filmed on location, the puppet aliens were ultimately replaced with CG versions.*



*The dissection alien was puppeteered with rods and pneumatics through a hole in the floor of the set. Harlow and MacDonald portrayed soldiers in the scene, manipulating the puppet for maximum performance.*



correcting itself. Sometimes you'll see a thruster misfire and there will be a puff of smoke coming out of it, as if it's backfiring. It's a very environmentally unfriendly ship!"

Soho used The Embassy's ships in its nine composites for the botched helicopter escape and destruction, which plays out in stages—the chopper first bursting into flames in midair, then crashing into the ground, and finally blowing up into a million pieces. "It starts with the live-action shots of people getting into the helicopter," said Soho visual effects supervisor Keith Sellers, "and then we take over in the shot looking up into the sky where you see the alien ships fly in and attack the helicopter. We put in the CG helicopter and the alien ships. We modeled and textured the helicopter all in-house, with Andrew Winters doing most of the modeling. Production provided us with a lot of reference photography of the real helicopter, which we used for textures."



Nantz and his squad evacuate the police station, but are soon menaced by an alien drone ship. Visual effects supervisor Winston Helgason and his crew at The Embassy modeled the drone, detailing it with many hoses and greasy textures to create an industrial, low-tech look characteristic of all the alien hardware. Embassy artists developed an unusual thruster pattern for the drone in Houdini, based on YouTube reference of the 'Multiple Kill Vehicle,' a NASA jet-propelled satellite used in rocket defense. Houdini simulations generated the look of dust and debris being kicked up by the drone as it flies low to the ground.



Jonathan Liebesman and visual effects producer Kevin Elam examine a practical drone maquette on set.



In addition to adding the ships and helicopter to the plates, Soho had to incorporate all of the explosion elements and debris. “As always, Jonathan was very picky about CG explosions for this sequence,” commented Everett Burrell, “and so we had to shoot a lot of real elements once we got back to Los Angeles. We shot elements at Cinema Production Services, with Mike Joyce, for this and other scenes in the movie.”

The CPS pyro elements were used for shots of the helicopter exploding after it has crashed to the ground. “We used that element in combination with another general explosion element they had shot,” Keith Sellers explained, “combining the two to get the actual helicopter explosion, and also combined it with fluid simulations. We also added more debris, because they wanted to see a lot of pieces flying at the camera and filling the frame. To generate larger chunks of debris, we broke pieces off of the helicopter and then modeled a series of bent and broken pieces and hand-animated them. For the rest of it, we used dynamics simulation with rigid bodies to add pieces flying around.”

The surviving *Marines* on the ground take cover in an abandoned police station in Santa Monica, and hole up there while strategizing their next move. Two make their way to the roof of the station to survey the scene around them. Spin created the large vista of a burning Santa Monica, as seen from the rooftop. “We shot that on a rooftop in Shreveport,” recalled Everett Burrell, “and originally it was just going to involve a couple of little matte paintings. But once we got into the cut, we found that we needed a whole view of Santa Monica being destroyed.” The shots also featured a dogfight between F-18s and alien drones in the distance. “Spin did an amazing job creating a big scene that wasn’t originally intended to be that big. Every time the camera looks out from the rooftop, it’s completely Spin’s work.”

Comprised of 35 effects shots, the rooftop sequence was Spin’s biggest on the show. “This is the first glimpse of what’s really happening out there with the aliens,” Jeff Campbell commented. “We built a 270-degree view of an all-out battle—everything beyond the roofline is CG. The plates were all hand-held, which made for some difficult camera tracking. Everett provided reference stills for the



*Theorizing that the alien ship is tracking them via radio signal, Nantz positions a walkie-talkie next to a gas pump to lead the drone there, then throws a grenade to explode the pump and destroy the ship. One of The Embassy’s challenges in executing the 40-shot gas station sequence was integrating the CG drone into overcast plates. The team cheated in hot spots to create the effect of sunlight glinting off of the alien vessel.*



*The Embassy used Houdini and XSI dynamics simulations for shots of the drone blowing apart and then crashing close to camera in the wake of the gas station explosion.*

environment and HD video footage, which we used for blowing trees and the ocean.” The matte painting was a multiplane cyclorama built in Photoshop and Nuke to cover all the necessary angles. “Since these shots cut back to back, we had to keep a close eye on continuity. Live-action elements, like smoke and explosions, and all of the animation for the F-18s, drones and a squadron of aliens in ground attack, had to flow from shot to shot. The drone ship was supplied by The Embassy as an XSI file, so we had to convert to Maya, re-rig and build new shaders for it to work in our pipeline. We had a challenging experience ingesting various flavors of assets.”

The rooftop-stationed Marines employ their military scopes to check out distant alien activity, and spot saucer ships unloading cargo as an alien general orchestrates the operation. Cinesite modeled the general for a later sequence, and then shared that model with Spin. “The general alien is more squid-like than the infantry aliens,” explained Ben Shepherd. “He’s got a mechanical lower body with multiple legs. That was a difficult model for us, mainly because all we had for reference were a couple of Paul Gerrard sketches—a profile and a front view. We stuck to his design as well as we could, but we had to play with it to get all the 3D mechanical parts to fit.” Rather than walk on multiple mechanical legs, the general floated from place to place—but there was nothing ethereal in the keyframe animation developed by Cinesite. “Jonathan liked the idea of these mechanical things only just being held together. He wanted them to look gritty and old, mechanically worn out, reused and repaired, and almost malfunctioning at times. So the animation had a popping, glitchy look.”

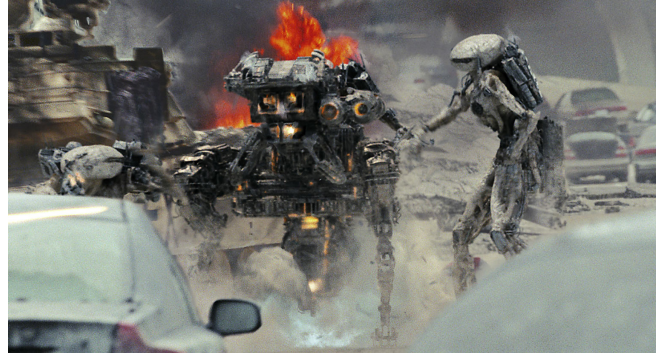
As reference for their shots, Spin artists were provided a very brief shot of the general from Cinesite’s later sequence. “We used motion capture for the general’s upper body,” noted Campbell, “and keyframed his root-like legs to move as if they were under water.”

Finding an injured alien at the police station, the Marines perform a dissection to determine how to kill the seemingly impervious creature. Both the injured alien and the ‘autopsy’ alien were practical puppets built and operated by makeup and creature effects supervisor Joel Harlow and his crew. “We had to build a full-size version of the alien for interaction with the Marines when they find it,” said Harlow. “Then, for the actual dissection, we took the legs and arms off of that hero version, and put them on a separate autopsy version. We also replaced the chest cavity with one that could be cut open to reveal all of the internal workings.”



*The Marines engage the aliens in battle on a Los Angeles freeway. Production shot live-action for the sequence on a closed section of freeway in Shreveport that offered a view of a very L.A.-looking overpass in one direction. For camera angles facing the opposite direction, production erected an 80-by-40-foot greenscreen. A team at Hydraulx, led by visual effects supervisor Bill Kunin, added Los Angeles backgrounds to the Louisiana freeway set, building proxy structures in CG onto which the team projected photography and matte paintings. Hydraulx also enhanced large-scale explosions orchestrated on set by special effects supervisor Stan Parks.*

To build both versions, Harlow's team photographed one of the alien maquettes, and then enlarged the photographs, giving them a full-size profile, three-quarter and front view of the creature. "We built our armature based on that," said Harlow, "and sculpted it the old-fashioned way, in clay. It's supposed to be biomechanical; so we used a lot of silicone, as well as fiberglass and found parts. We incorporated a lot of old computer and machinery parts into it, especially in the gun arm."



*The freeway battle introduces another piece of alien hardware – the walking gun, a missile-firing weapon held aloft by a jetpack and guided by two alien 'drivers.' To suggest a consistency of technology, Hydraulx modelers assembled the walking gun using many of the same assets it had built for the infantry alien's biomechanical gun arm. Hydraulx added its CG walking gun, infantry aliens and digitally enhanced smoke and fire elements to background plates shot on the freeway set.*

The design of the interior of the chest cavity, seen after the Marines have sliced open the alien's torso, was largely left to Harlow's team. "There were some preliminary designs of the interior," stated Harlow, "but to accommodate the working mechanisms we had to alter those. The final chest cavity piece had glowing pieces, smoke rigs and pulsating breathing rigs. We puppeteered it through a hole in the floor of the set using rods and pneumatics—all hands-on, no remote control. It took about ten puppeteers to move the alien because of all the working parts." Harlow and one of his crew members, Lenny MacDonald, portrayed the soldiers manipulating the alien in the scene.

A story point revealed in the dissection scene is that the clear liquid that comes out of the aliens when they are shot—and when the injured alien is cut open—is none other than salt water, a substance the aliens have learned to convert to fuel. Spin added digital water effects and practical water elements to the dissection shots, and executed CG tweaks to bring the alien to life. "We gave it a soul," said Jeff Campbell. "We made the eyes and ears move, and added twitches. It had an eyepiece that scanned across the head, and a mouth that looked like a vibrating bladder. None of those elements was functional on the practical puppet, so we made them functional in CG. There was also a leg that was broken off, with a long CG tentacle hanging out that we animated to twitch and move." Spin created a heart-like pump, as well. "You see water flowing through this pump, which we built in CG, using fluid effects to create the water that gushes out when it is stabbed."

The *Marines* attempt to make their way back to the FOB in a bus, the interior of which had greenscreen covering the windows to allow for environment replacements by Luma Pictures. "We did about 20 of those shots," said Vincent Cirelli. "Production gave us a lot of photography of the Los Angeles area to choose from; and based on the layout dictated by Everett, we would pick the photography that worked best for each shot. These weren't plates that were shot specifically for those scenes—just a lot of photography and various angles for us to choose from."



“Once the photographs for each angle were selected,” added Richard Sutherland, “we stitched them into a cyclorama in Nuke that all of the compositors could use. We would figure out which direction the camera was facing out the windows for a particular shot, and use this unified environment that we could then change and re-render as the exterior changed.”

The bus and its occupants are soon menaced by alien saucer ships flying overhead, with one drone separating from the mothership to stalk the vehicle. Theorizing that the aliens are tracking them via radio signal, Nantz positions a walkie-talkie next to a gas station pump, leading the drone there, then throws a grenade to explode the gas pump and destroy the ship. The Embassy took on the 40-shot sequence, largely because it prominently featured the alien ships the company had been charged with creating.

One of the challenges of the sequence was integrating the ships into overcast plates that had been shot in Shreveport. “Jonathan wanted sunlight to be glinting off of the drones,” said Winston Helgason, “but it was difficult to do that in these overcast plates. So we had to fight that a bit in the gas station sequence, cheating in hot spots.”

The drone flies low to the ground as it searches for the source of the walkie-talkie signal, kicking up debris and dust, which The Embassy’s Paul Flanagan and Robert Kelly created through some complex Houdini simulations. “Toward the end,” said Helgason, “Jonathan wanted even more dust and debris in those shots, so we added passes of paper and small rocks and other things kicking around. We also used elements in a couple of places where the debris is right under camera. In the end, it added quite a bit to the shots and really sat the drone into the plate.”

Stan Parks had rigged a massive practical explosion on set for the shot of the gas station blowing up, which The Embassy enhanced with CG pyrotechnics. “We had a CG gas station exploding on top of the real gas station,” Helgason said. “A piece of the drone blows off when it crashes into the roof, and then it goes tumbling through the air and crashes down in front of camera, which involved a collaboration between our Houdini team and Paul Copeland, who created XSI dynamics simulations. There’s also a CG fireball and some practical elements mixed into that. We used fire and smoke elements for shots of the drone settling on the ground—both elements Everett had shot and some from our library—and we mixed those in for the fire and smoke around the crashed drone ship.”



*During a reconnaissance mission, the Marines detect a dark grid in the cityscape below, signaling the position of the aliens' underground command center. Visual effects supervisor Craig Barron and his team at Matte World Digital created a shot intended to make the dark area read more clearly, thereby emphasizing the story point. MWD started with a nighttime aerial plate of Los Angeles and tracked in a painted grid pattern with enhanced building details to delineate where the illuminated city blocks ended and the dark grid began. Artists at MWD positioned burning L.A. buildings scribbled from a previous shot by Intelligent Creatures into the horizon of their shot, and also added 3D ships, interactive lighting and pyrotechnic elements.*

The drone crash was one of the most complex shots The Embassy delivered for the show. “We went through quite a few stages of animation just to get the crash itself to look right,” remarked composite supervisor Stephen Pepper. “And then there were all these elements to deal with in the composite—the ground ripping up and bits coming off the drone and flying through the air. Jonathan was always going for a hand-held, frenetic look: but this particular shot was locked off, so we had to add all that frenetic movement.”



*Nantz and his squad enter the city's sewer tunnels in search of the alien command center. Production shot the tunnel sequence on sets at the Celtic Media Center in Baton Rouge. Cinesite extended the practical sets via matte paintings, added steam elements to practical smoke shot on set, and built and animated the alien general orchestrating his troops. Cinesite also implemented a series of strobing tracer effects for a firefight that erupts when the Marines cross paths with the general and his guards.*

Though the *Marines* score one for the home team at the gas station, they are soon in battle against the aliens on a Los Angeles freeway. Production had shot the live-action for the sequence on a closed section of freeway in Shreveport. “That was a good location,” recalled Everett Burrell. “In one direction was this beautiful overpass that looked very L.A. In the other direction was the town of Shreveport, so we had an 80-by-40-foot greenscreen erected at that end. We had to add L.A. to the high and wide shots, but a lot of times we were able to get what we needed in camera.”

Since Hydraulx was tasked with delivering approximately 100 shots for the sequence, Bill Kunin was on set for the shooting of the freeway battle, coordinating with Burrell, visual effects producer Kevin Elam, production data wrangler Chris Moore, and visual effects coordinator Kathy Lew. Stan Parks was also on set, creating large-scale explosions and firepower. “Stan and his crew blew up a lot of stuff on that freeway,” said Burrell, “including the bus that our characters are in. And then, for stuff we couldn’t do on set, I went out with Stan and a small crew to a desolate area in Baton Rouge and shot a ton of elements—explosions and smoke and sparks and things like that.”

To add Los Angeles backgrounds to the freeway set, Hydraulx built proxy buildings in CG and projected photography and matte paintings onto them. “Some of it was just old-school 2D matte painting,” Bill Kunin said, “but the cameras were all over the place in those shots. We had a Lidar scan, as well as camera information, so we knew where everything was shot, physically, on the freeway. By projecting matte paintings and photos onto CG proxy geometry, we then had renders that had the correct position, scale and track, which meant we didn’t have to do a lot of guesswork in 2D.”

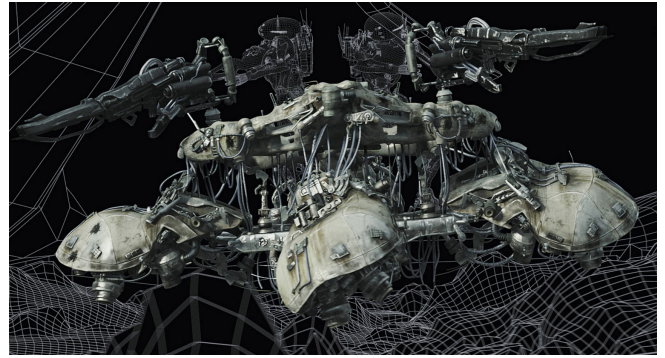
The freeway sequence serves as introduction to another piece of alien hardware—the walking gun, a large, missile-firing bipedal weapon, held aloft by a jetpack in its back and guided by two alien ‘drivers.’ Hydraulx lead modelers Yoshiya Yamada and Miguel Guerrero enjoyed some latitude in building the walking gun, since production did not provide an approved model. “All we had were a couple of general references,” stated Kunin, “so we had more leeway there. We’d built the alien’s gun arm from scratch, and we used some of those elements for the walking gun, so it would look as if it derived from the same technology. Jonathan wanted it to have more of a rudimentary, built-in-a-garage type of feel, rather than a super-high-tech, slick feel.”

The *Marines* survive the freeway battle and make their way to the Santa Monica FOB, only to find it demolished. The reveal of the FOB destruction was a large CG matte painting executed by Cinesite. The *Marines* then depart the FOB in a helicopter; and from that aerial point of view they detect a dark grid in the cityscape below, which they suspect marks the underground position of the aliens' central command center.

Everett Burrell engaged Intelligent Creatures to create several shots of the burning nighttime city from the aerial perspective. "It was a pretty big sequence," commented Intelligent Creatures visual effects supervisor Geoff Scott, who oversaw the shots with the company's founder, Lon Molnar. "Production had shot the actors bluescreen in a helicopter shell on a gimbal rig. So we provided the aerial backgrounds, doing a lot of matte paintings. We were given some daytime reference plates to guide us, but all of the backgrounds were original matte paintings. The reference was of downtown Los Angeles, so that's what we created in some of our shots—views of that same area, but at night, and with buildings on fire. The rest of the shots were located in a generic industrial area. For the fire, we combined CG fire and elements in Nuke, mapping the elements onto cards and placing them in three-dimensional space."

Fires are ignited by white phosphorus the aliens drop from their aircraft. Intelligent Creatures used the Embassy ship assets in the shots, and composited in phosphorus elements shot by Everett Burrell. "We had literally terabytes of smoke and this phosphorus footage handed over to us," said Scott. "We went through it and selected the best bits, mapped them to cards in Nuke, and placed those cards in relation to the ships dropping these flares."

Matte World Digital contributed a couple of subsequent shots designed to emphasize the dark grid pattern in the cityscape below. "It just had to look strange," explained MWD visual effects producer Ken Rogerson, "so that the *Marines* wonder what is going on there. That was the point of the shots. We put Intelligent Creatures' burning L.A. buildings into the horizon of our shot; and so, as the helicopter is flying away from downtown Los Angeles, it all cuts together as a progression, until we come across this dark grid."



A final battle has Nantz and one of his men maintaining a laser target on a vital alien antenna as their fellow Marines engage in a fierce firefight with the invaders. Alien drones enter the fray, along with another alien ship – a hovercraft armed with massive machine guns. The giant hovercraft, three times the size of the drone ship, was designed by Everett Burrell and concept artist Paul Gerrard, and was modeled, animated, rendered and integrated into live-action plates by Cinesite.



The Marines knock out the hovercraft, clearing the way for guided missiles to destroy the alien antenna and thus cut off communications between the alien command and its forces.



“It was tricky,” added MWD supervisor Craig Barron, “because it was supposed to be something you almost didn’t see at first—just a strange black shape made by an outline of city blocks where there wouldn’t be any visible lights. The production sent us a helicopter plate of Los Angeles, shot at night. We kept all the nuances of reality, parallax and shake; but filming something night for night is not as pretty as you might want, and we just couldn’t see much. So we decided to relight our helicopter plate by tracking in a painted street grid pattern with many more building details so you could really see that the edge of the city blocks stop abruptly around a dark area.”

Digital matte artist Eric Hammel led the way on the shot, which also features alien spaceships in the distance, firing on the landscape and creating explosions. Va Ha created the 3D ships and interactive lighting, which compositor Todd Smith put together with pyro elements that had been shot by Everett Burrell. “We tracked all those elements into our shot, as well,” said Barron, “and then created a little interactive lighting element so that every time an explosion went off you would see its result on the sides of buildings.” MWD’s shot is also seen in nightvision scopes, for which the company did a second version. “Technically, production did the nightvision part in D.I., but we gave them two different renders at two different focal lengths.”

Nantz and his platoon follow aliens into the city’s steamy sewer tunnels in search of their command center. Production shot the tunnel sequence on sets at the Celtic Media Center in Baton Rouge. Cinesite extended the practical sets via matte paintings, added steam elements to what had been shot on set, and built and animated the alien general orchestrating the troops. “They did a lot of practical steam on set,” said Ben Shepherd, “but we did an element shoot and padded it with those elements to create more steam.” Cinesite did a series of fast, strobing combat shots for a firefight that erupts when the *Marines* cross paths with the general and his guards.

The *Marines* climb out of the sewers and into a decimated area of Los Angeles, where an alien antenna—part of the subterranean command center—sticks out of the ground. Cinesite fleshed out Paul Gerrard drawings of the antenna and built it as a digital asset. “It has all these bits and pieces ramshackled together,” said Shepherd. “We also matte-painted environments surrounding the *Marines* as they huddle to plan their next move, which is to point a laser target at the antenna and direct a missile there to blow it up.”

A long final battle sequence ensues as Nantz and Lockett (Cory Hardict) maintain a laser target on the antenna and their fellow *Marines* engage in a fierce firefight with aliens. Cinesite took on the initial part of the final battle, in which the general and infantry aliens burst out of the ground, their weapons blazing. “There’s a lot of tracer fire,” said Shepherd, “and then explosions as the *Marines* plant bombs in the ground and blow the aliens apart. Most of the shots have full CG aliens in them, and there are a couple of full-screen, full-body shots as they make their way through the debris toward our heroes.”



Hydraulx picked up the battle action with shots of the subterranean command ship erupting from the ground. Hydraulx built the CG command ship, working from 2D artwork, and composited it into a live plate filmed on a destroyed downtown Los Angeles street set built in Baton Rouge. For shots of the command ship being taken out by a guided missile drawn to the laser target, Hydraulx composited an animated CG missile into the shot, along with tracer fire, CG drones, CG debris and real dust

elements, and augmented the digital explosion with pyrotechnic elements shot practically at Cinema Production Services.

Drones enter the fray, along with another alien aircraft heretofore unseen—a hovercraft armed with massive machine guns. The hovercraft was designed by Paul Gerrard and Everett Burrell. “Jonathan wanted to see another new alien vehicle at this point,” remarked Burrell, “so we came up with this gun platform. We gave the concept art to Cinesite, and they did a great job adding in all of the details and mounting two aliens on top.”

“The hovercraft is about the size of three drones,” Ben Shepherd related, “and there’s a huge gun battle between the aliens on the hovercraft and the *Marines*. Eventually, they manage to knock out the hovercraft and the guided missiles come in and blow up the antenna. There are four shots of the missiles hitting, and there are all these concussive shockwaves and explosion augmentation. The whole ground is shaking and the antenna crumbles to the ground—and that’s the end of our part of that sequence.”

Hydraulx picked up the action with shots of the subterranean command ship erupting from the ground. Hydraulx built the CG command ship, which—like all of the show’s designs—evolved throughout production. “The size of the command center changed,” recalled Bill Kunin. “Initially, it wasn’t nearly as big as what it ended up being, which was something like three football fields long, with a massive domed top. Modeling the command center was difficult because we had only two images to work from, a front hero view and a side view—and when we started modeling, it was clear that the side view didn’t really correspond to the front view. So we had to blend the two, and there was some back and forth to get that right. Then, once we got the two views to match and put the model in the scene, it just didn’t feel massive enough. So we did some reportioning to make the top part bigger.”

A building adjacent to the massive ship crumbles as the craft emerges from the bowels of the earth. Hydraulx brought down a CG building for the shot, and also employed dynamics to break apart CG cement surrounding it. Lead compositors Laura Sevilla and Loeng Wong Savun also added a matte-painted cityscape in the background, with CG supervisor Colin Strause and lead lighter Oliver Arnold ensuring that all the elements fit together in the live-action plate.

The *Marines* laser-tag the ship, hoping to take it out with another round of guided missiles. “While they’re doing that,” said Kunin, “they’re being shot at by the aliens both on the ground and from airborne drones, and the action is all very hand-held. We did all the tracer fire and explosions, as well as the missiles that finally come in and take out the command ship. You see the missile hit it, and then it crashes down; and since this thing is the brain of the whole operation, the airborne drones start to crash, as well.”

The film ends with a shot of the surviving *Marines* taking off in Medevac helicopters as F-18s arrive to



Having disabled the aliens – for now – the surviving *Marines* take off in medevac helicopters as F-18 jet fighters arrive on scene to finish the job. The film ends with a spectacular 30-second all-CG wide shot, executed by the artists at Spin VFX, in which the camera pans up to reveal a dozen airborne helicopters and two F-18s

finish the job. Spin realized the last shot, building shaders for a helicopter asset that was provided to them. “At the last hour,” said Jeff Campbell, “Spin was awarded a bunch of helicopter shots, including the final shot in the film, where the camera pans up to a spectacular, wide, 30-second CG shot with a dozen helicopters and two F-18s overtaking the camera, against a backdrop of the total destruction of L.A. No pressure at all! This shot was finished by Amy Daye, our lead compositor, and she did an awesome job.”

*overtaking the camera against a backdrop of a burning, war-torn Los Angeles.*

The film’s denouement has mankind emerging victorious against the alien invaders—for now—laying the groundwork for future franchise productions that could present all-new action scenarios and combatants in various cities around the world. If such productions manifest themselves, they would do well to engage the services of the team of vendors that—though spread from Santa Monica to Toronto, London and Vancouver—came together in a cooperative effort to create the hundreds of effects shots for *Battle: Los Angeles*. “All of the vendors had a very good and mixed bag of tricks,” noted Everett Burrell, “and were able to do a bit of everything—some character work, some environment work, some effects animation. It was a real collaborative process, with everybody sharing assets and working together. It was my job to keep that collaboration going smoothly and make sure that everybody played nice.”

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